

Fig. 1

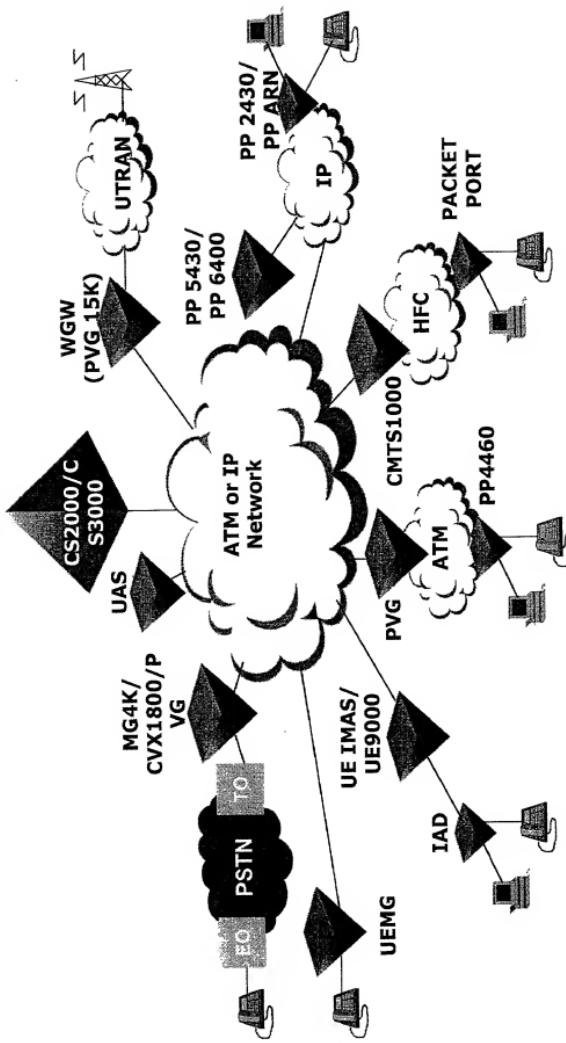


Fig. 2

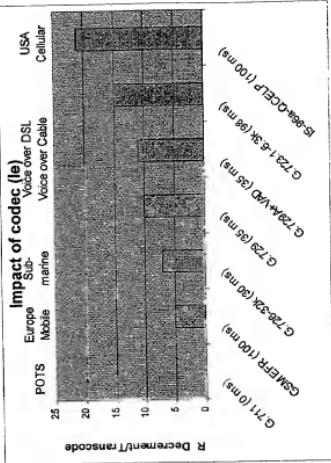
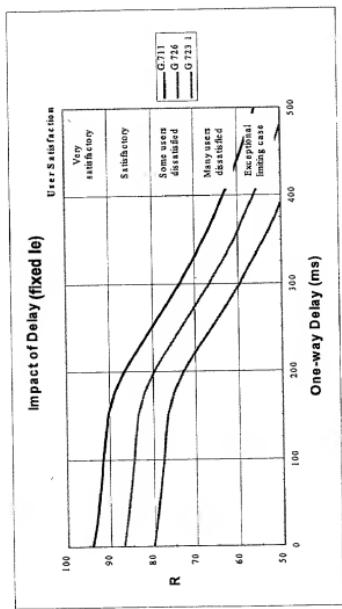


Fig. 3

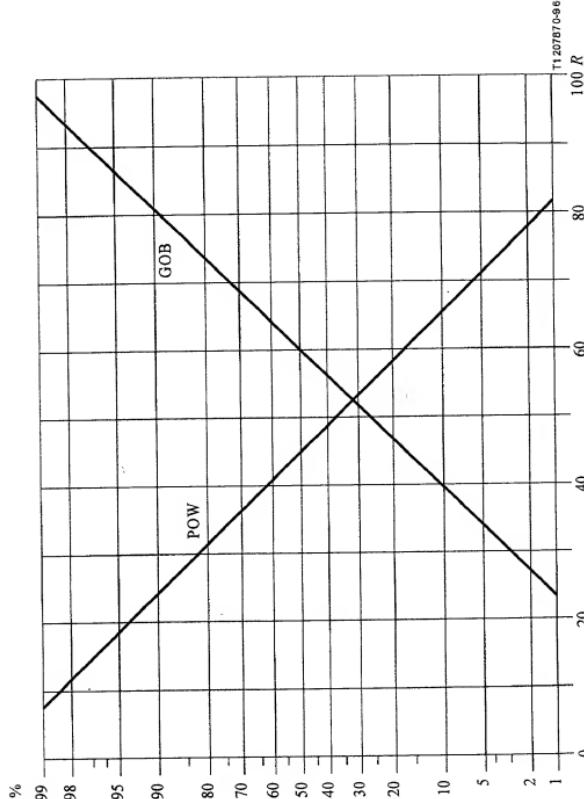


Figure B.1/G.107 - GOB (Good or Better) and POW (Poor or Worse) as functions of rating factor R

Fig. 4

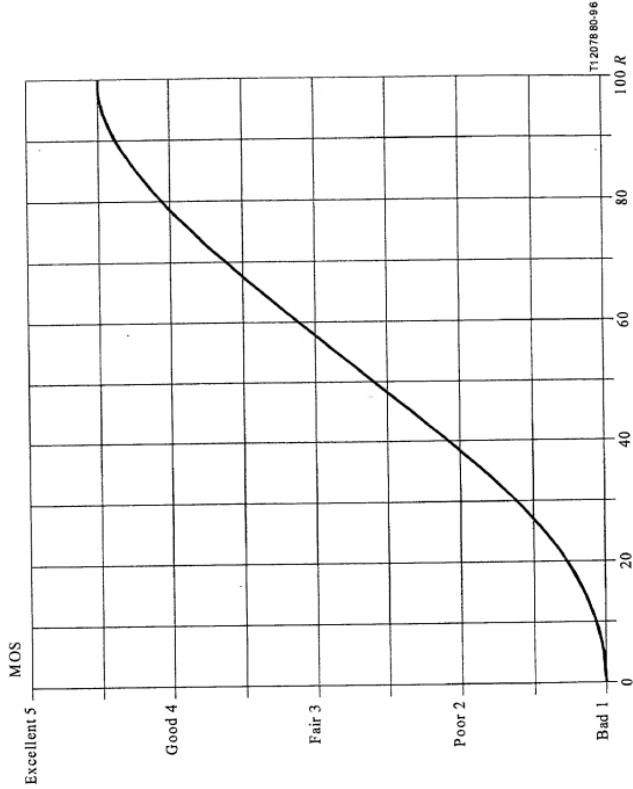
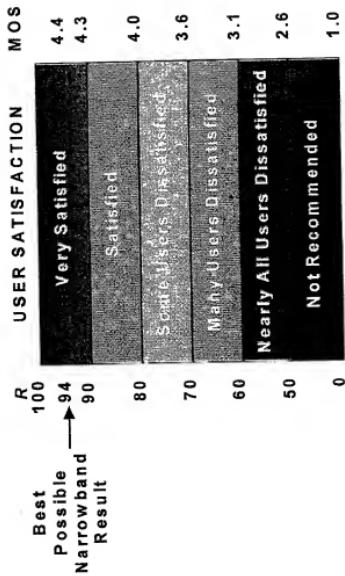


Figure B.2/G.107 – MOS as function of rating factor R

Fig. 5



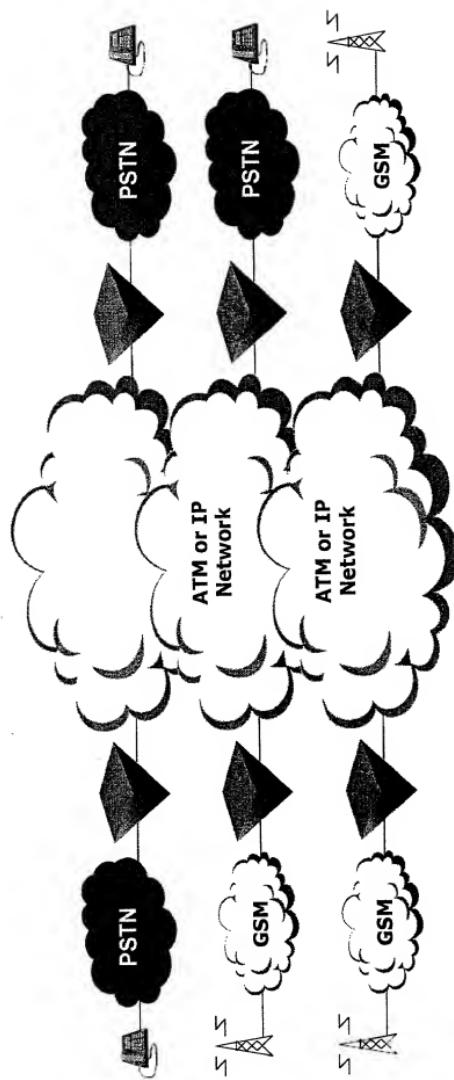
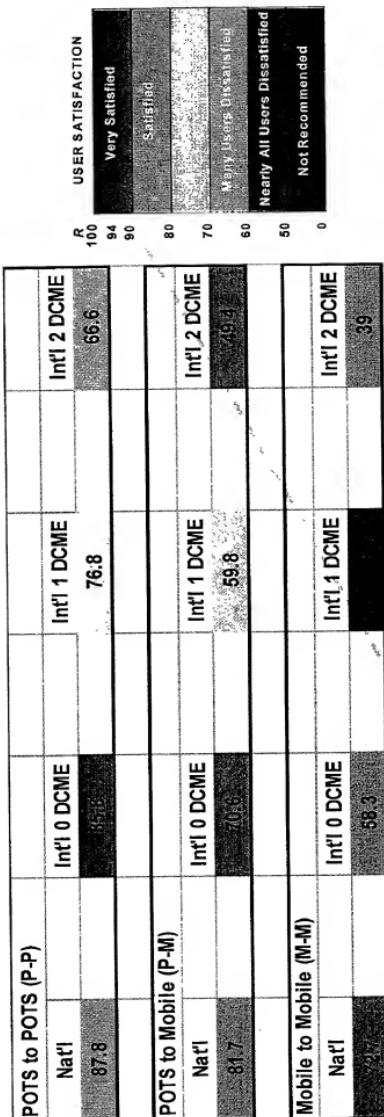


Fig. 6

Fig. 7



Limit of acceptability - a hard threshold

Mobile is GSM EFR.
POTS is modelled for an analogue set.
 $|\text{Nat'l}| = 80000\text{km}, |\text{Intl}| = 27500\text{km}.$

Fig. 8

What reference calls will be the most demanding quality measure?

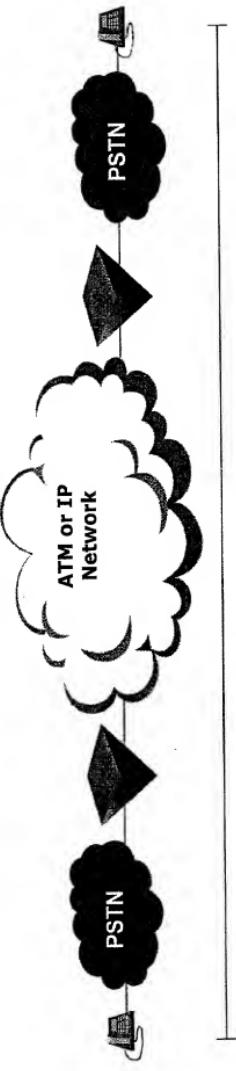


Fig. 9

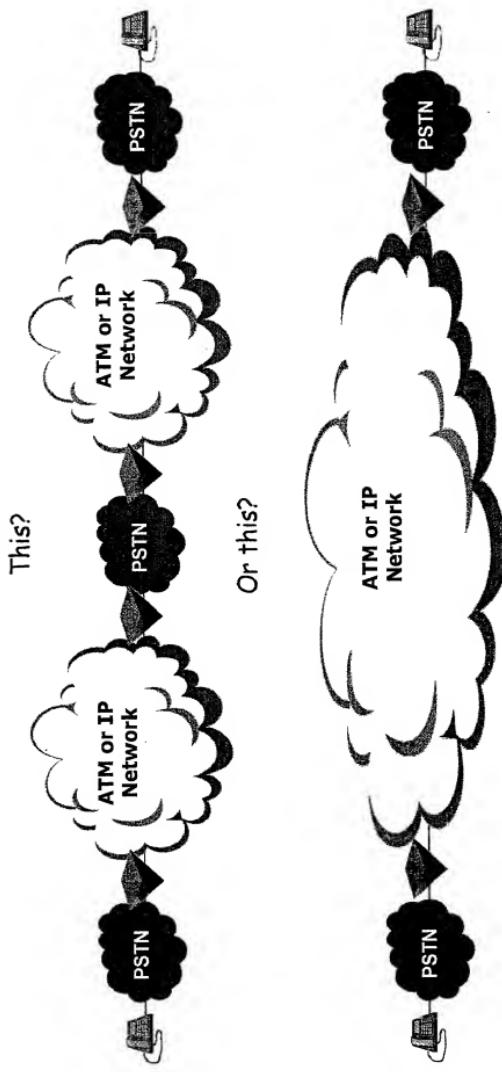
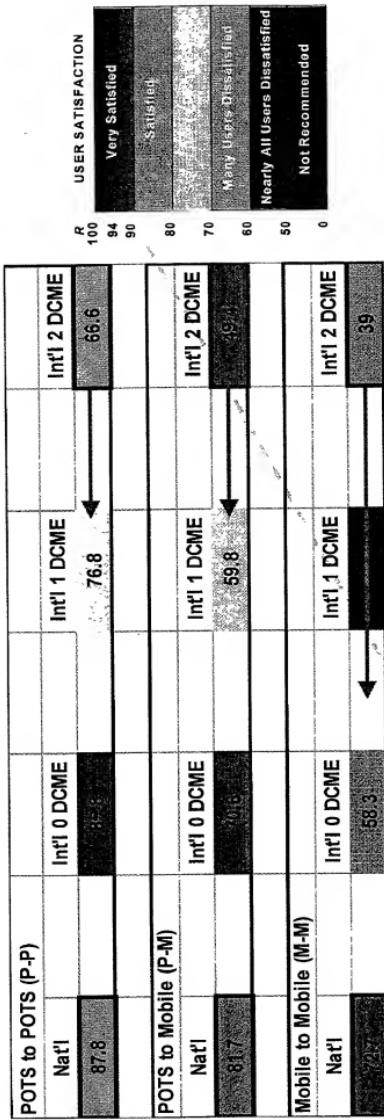


Fig. 10

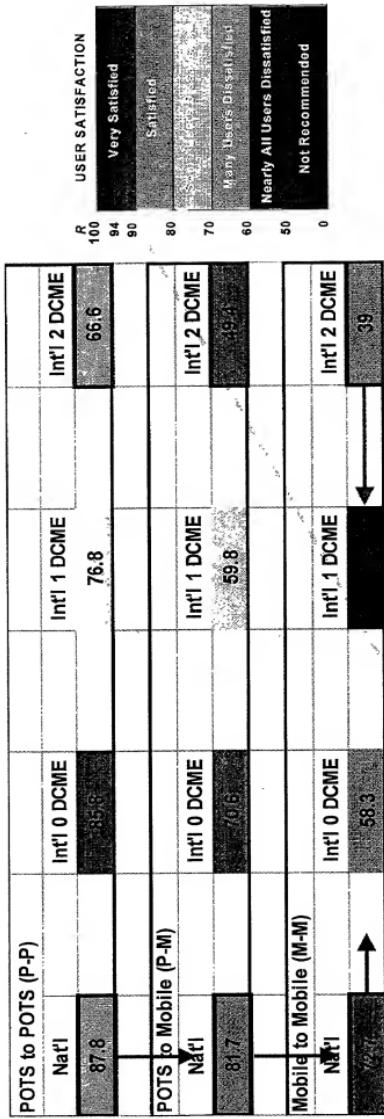


Limit of acceptability - a hard threshold

Mobile is GSM EFR, POTS is modelled for an analogue set. Nat'l = 8000km, Int'l = 27500km.

(*5R = 0.2 MOS over most of the linear range considered in the statistical noise by many practitioners.)

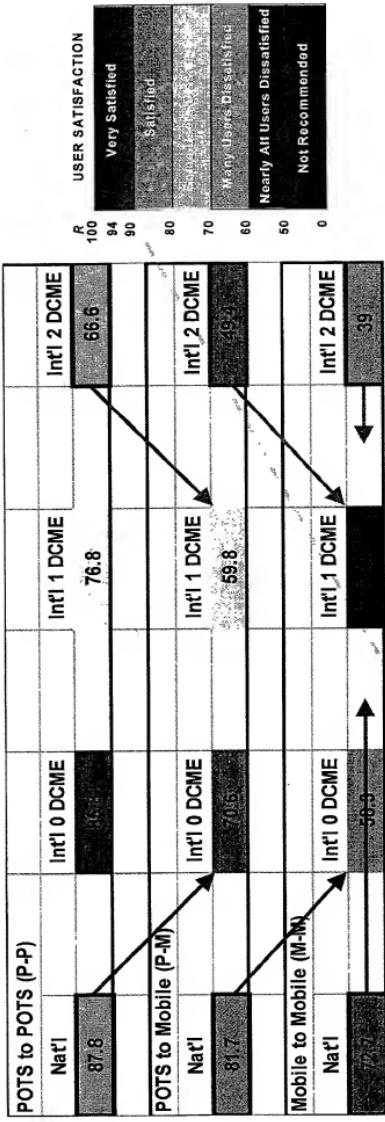
Fig. 11



Limit of acceptability - a hard threshold

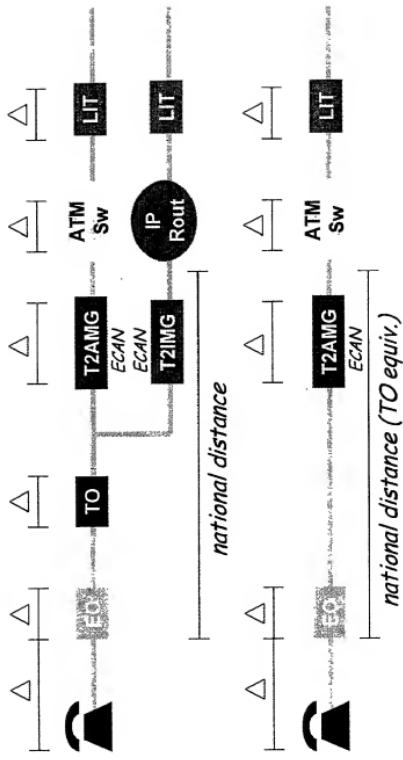
Mobile is GSM EFR, POTS is modelled for an analogue set. Nat'l = 8000km, Int'l = 27500km.

Fig. 12



Mobile is GSM EFR, POTS is modelled for an analogue set. Nat'l = 8000km, Int'l = 27500km.
 Limit of acceptability - a hard threshold

Fig. 13



THE JOURNAL OF CLIMATE

Fig. 14

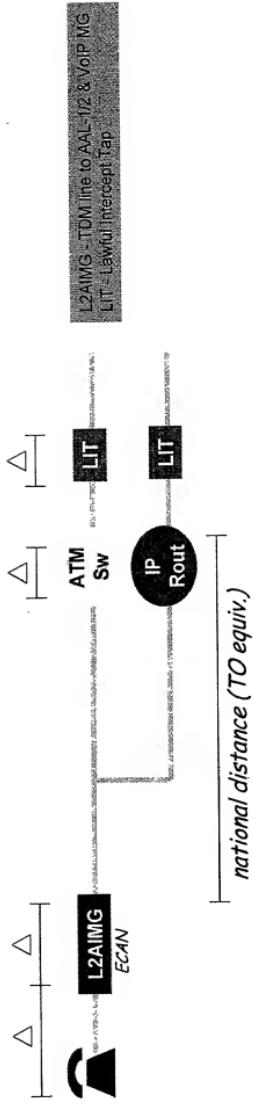


Fig. 15

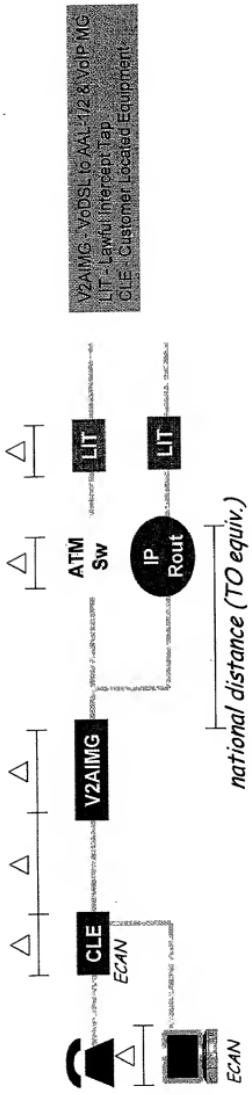


Fig. 16

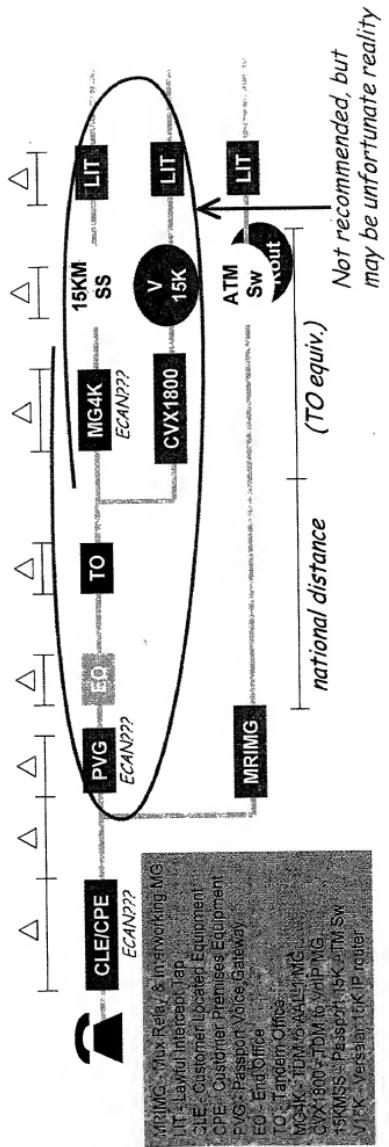
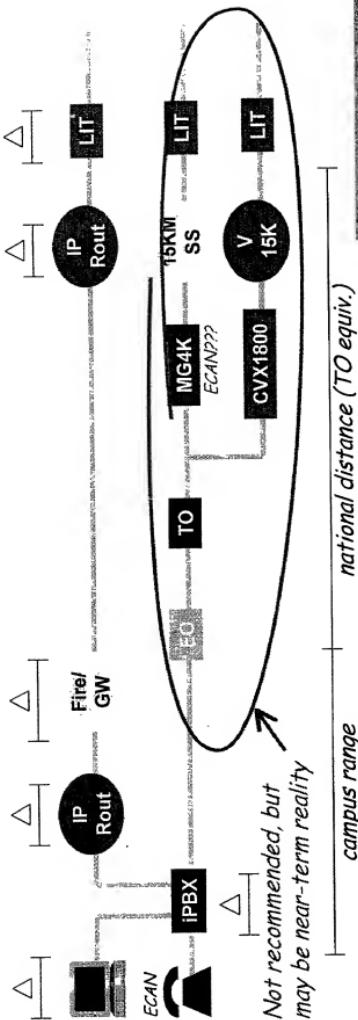


Fig. 17



MRMG : Mix Relay & Interworking MG
LIT : Last In Line Trunk Top
CLE : Customer Located Equipment
CPE : Customer Premises Equipment
PVG : Transport Voice Gateway
EO : End Office
TO : Telecom Office
MG4K : TDM to AAL-1 MG
CVX1800 : Trunk to VoIP MG
15KMS : Passport 15K ATM Sv
V/15K : Viasat 15K IP Sv

Fig. 18

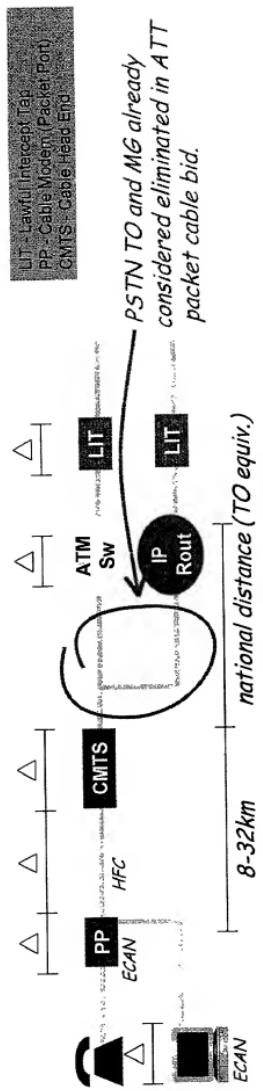


Fig. 19

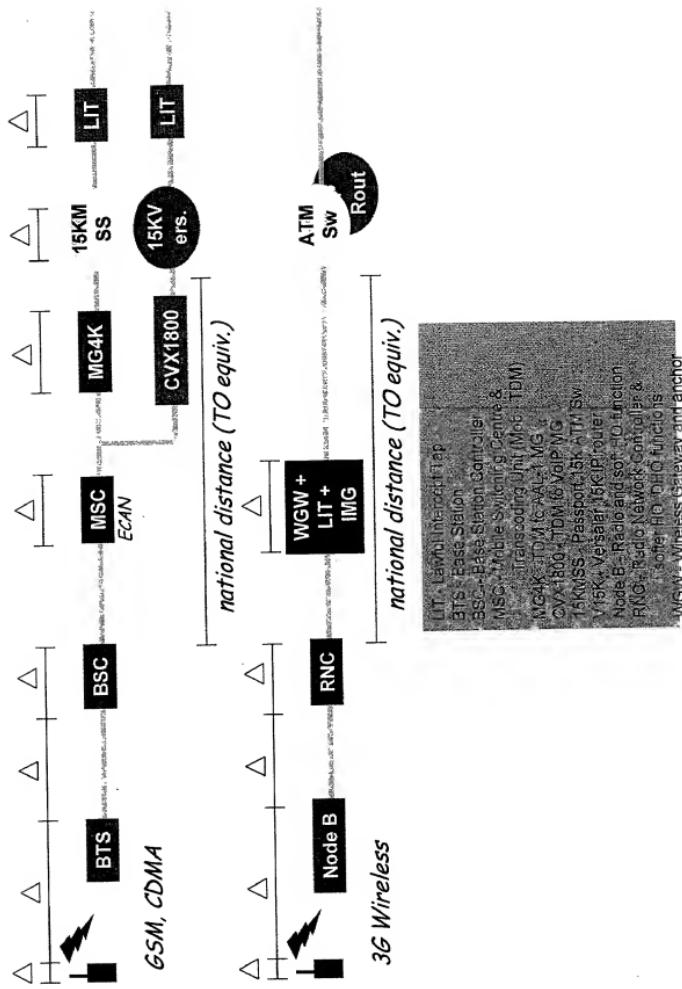


Fig. 20

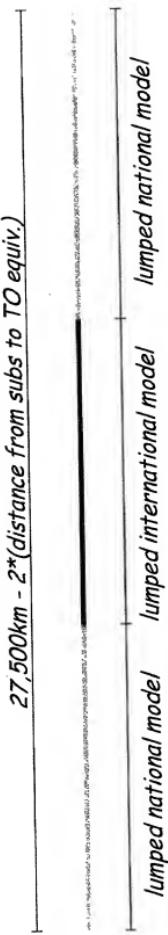
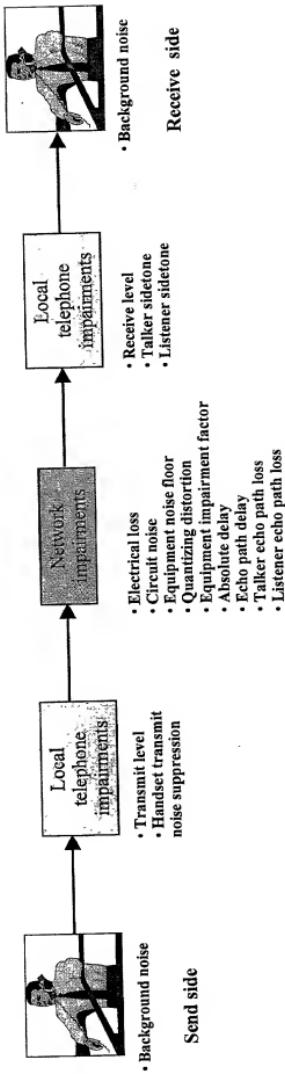


Fig. 21



The E-model calculates a Transmission Rating Factor R , given by

$$R = R_o - I_s - I_d - I_e + A$$

Fig. 22

E-Model Parameter Default Values

Parameter	Units	Value
SLR (Send Loudness Rating)	dB	8
RLR (Receive Loudness Rating)	dB	2
STMR (Sidetone Masking Rating)	dB	15
LSTR (Listener Sidetone Rating)	dB	18
OLR (Overall Loudness Rating)	dB	10
TELR (Talker Echo Loudness Rating)	dB	65
WEPL (Weighted Echo Path Loss)	dB	110
T (Mean Intrinsic One-Way Delay)	usec	0
ta (Absolute Delay)	usec	0
Tr (Round-Trip Delay)	usec	0
QDU (Quantization Distortion Units)	-	-1
le (Equipment Impairment Factor)	-	0
A (Expectation Factor)	-	0
Ds (Handset Shape Factor – Send Side)	-	3
Dr (Handset Shape Factor – Receive Side)	-	3
Ps (Room Noise at the Send side)	dB(A)	35
Pr (Room Noise at the Receive side)	dB(A)	35
Nc (Circuit Noise referred to 0 dB-point)	dBmOp	-70
Nfor (Noise Floor at the Receive Side)	dBmP	-64

Fig. 23

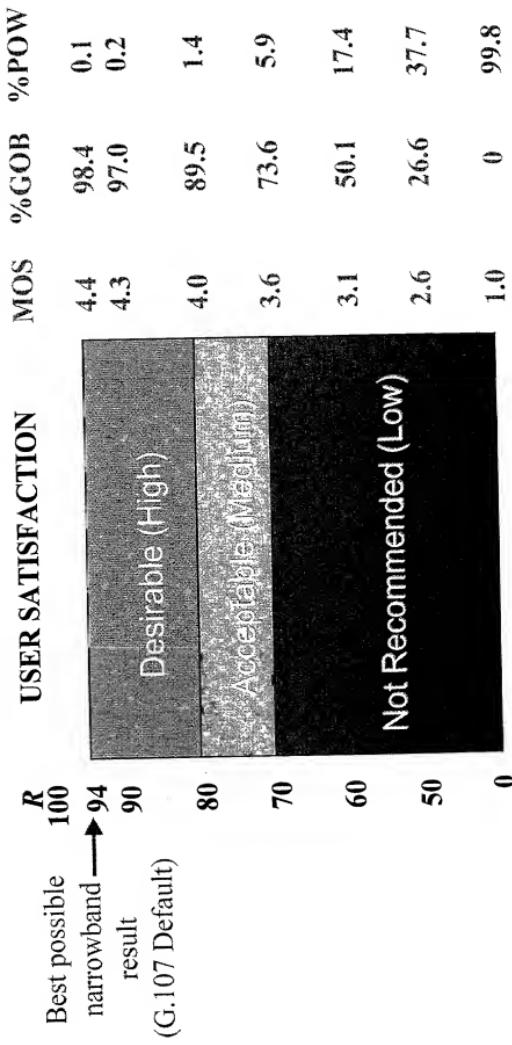


Fig. 24

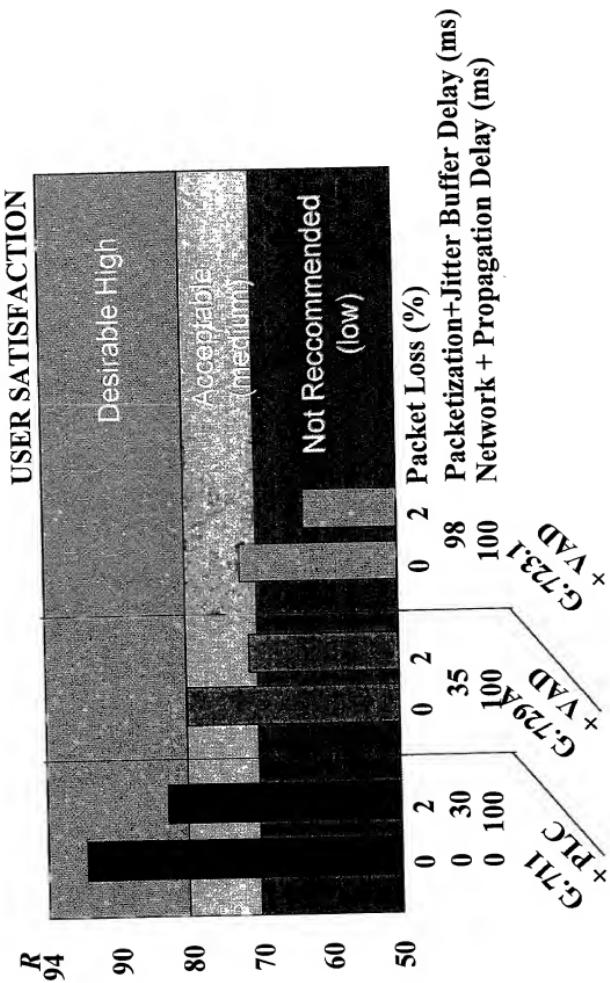


Fig. 25

e for E-Model Calculations						
	G.711	G.711	G.729A	G.729A	G.729A	G.729A
	[Notes 1, 2, 3]	[Notes 1, 2, 3]	[Notes 1, 2, 3]	[Notes 1, 3]	[Notes 1, 3]	[Notes 1, 3]
Frame Size (rms)	125	125	125	10	10	10
Packet Payload (ms)	10	20	30	40	10	20
Packet Loss (%)	0	0	0	0	11	11
	0	5	8	10	13	15
	1	7	13	16	19	19
	2	10	19	22	24	21
	3	12.5*	22	26	28	25
	4	15	25	30	32	29
	5	15	25	30	32	35

Notes:

- 1) In the absence of any supporting documentation, these are arbitrary values
- 2) All G.711 vocoders are assumed to have PLC (Packet Loss Concealment) algorithms
- 3) Impairment factors apply for random packet loss conditions
- 4) This is the current capability of the i2004 (in the absence of any download instructions to achieve smaller frame size)
- 5) There is no PLC algorithm for G.726, therefore its deployment might be limited in lossy network
- 6) Interpolated values

Fig. 26

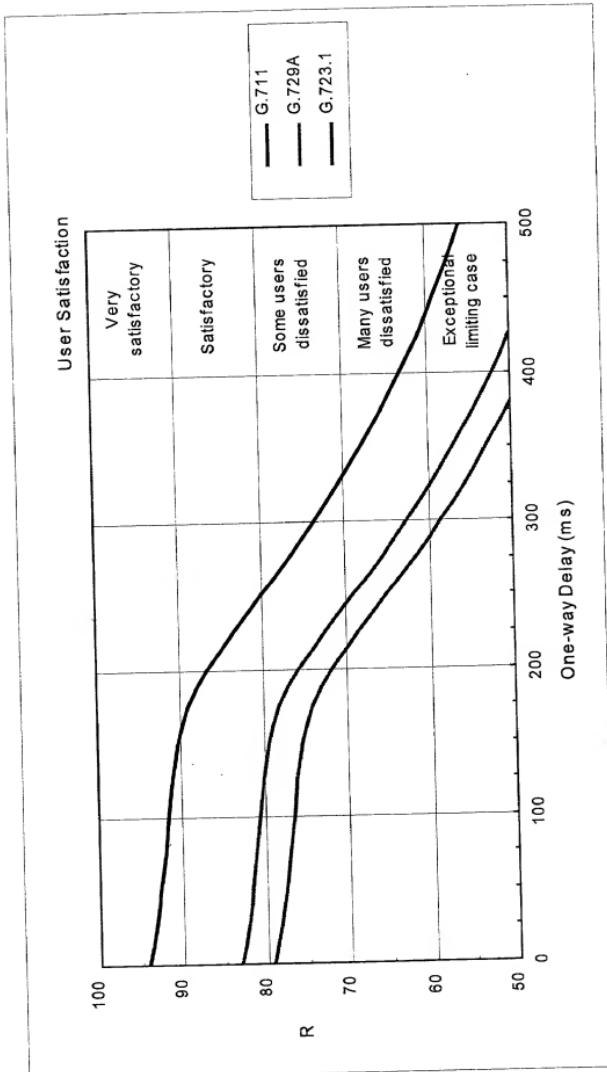


Fig. 27

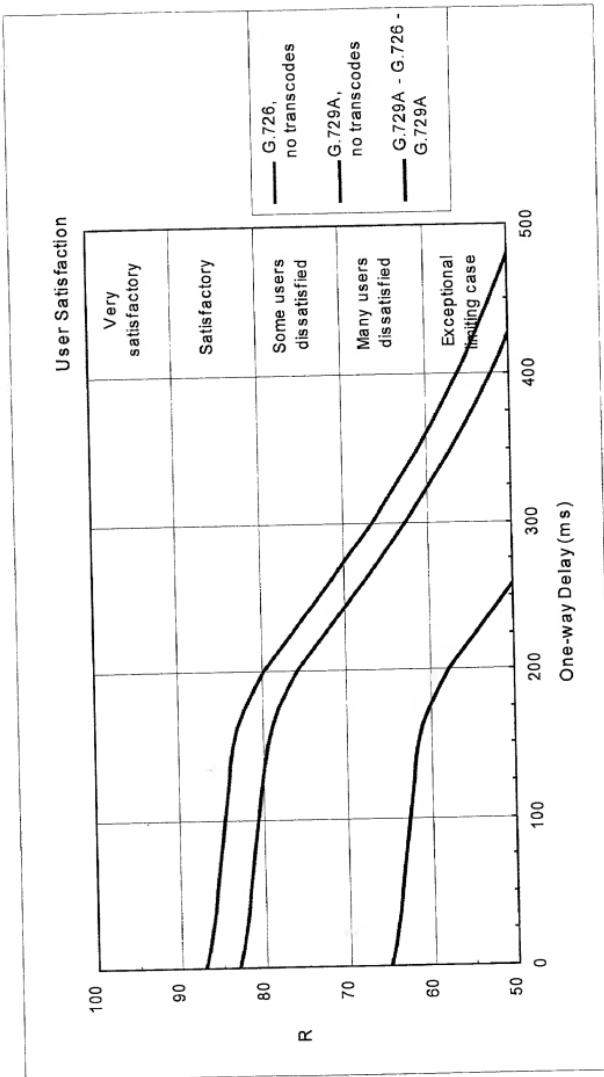


Fig. 28

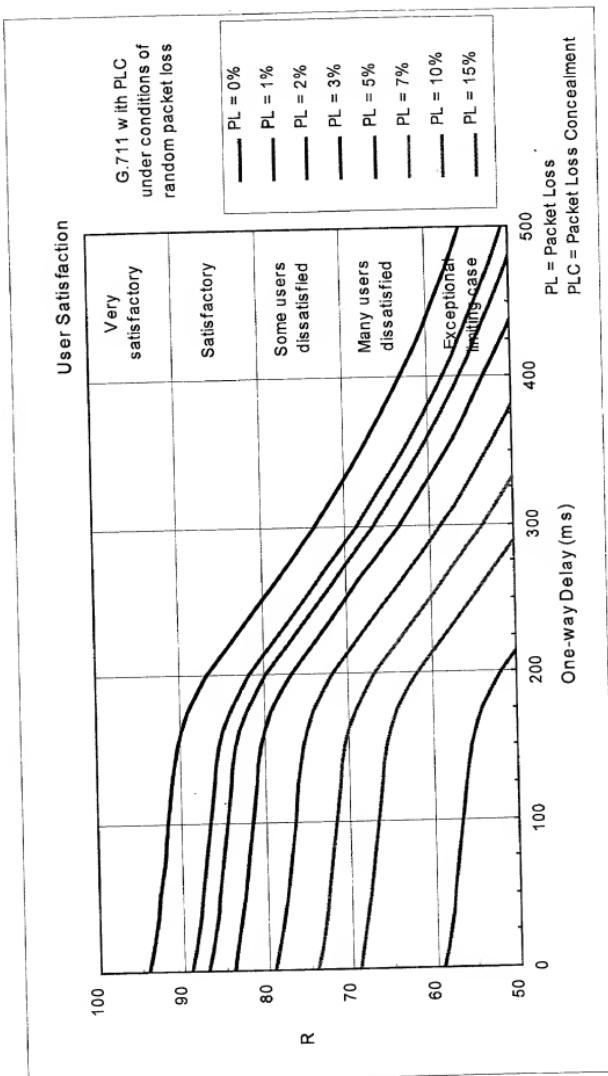


Fig. 29

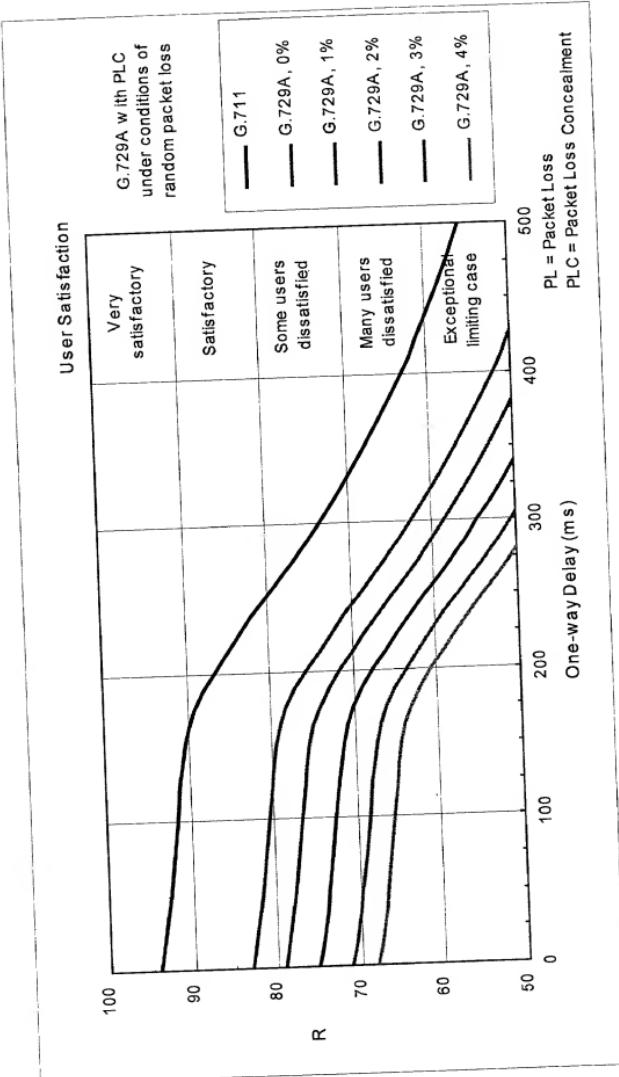
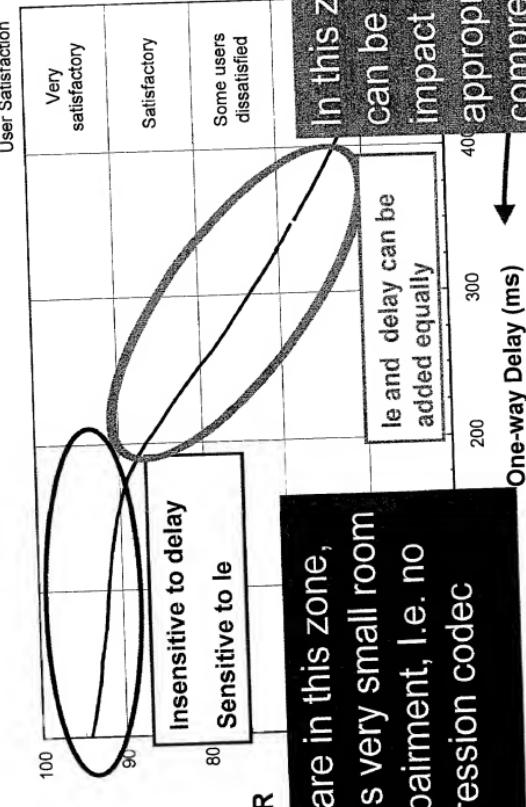


Fig. 30



In this zone, le and D can be added with less impact on "R". More appropriate for compression codec

le and delay can be added equally

If you are in this zone, there is very small room for impairment, i.e. no compression codec

Fig. 31

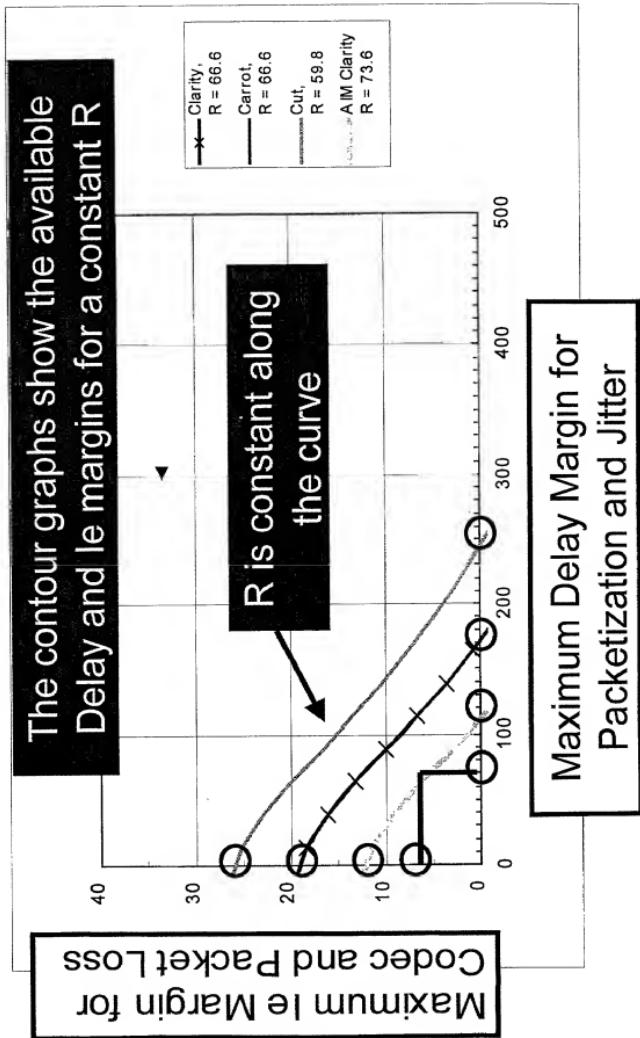


Fig. 32

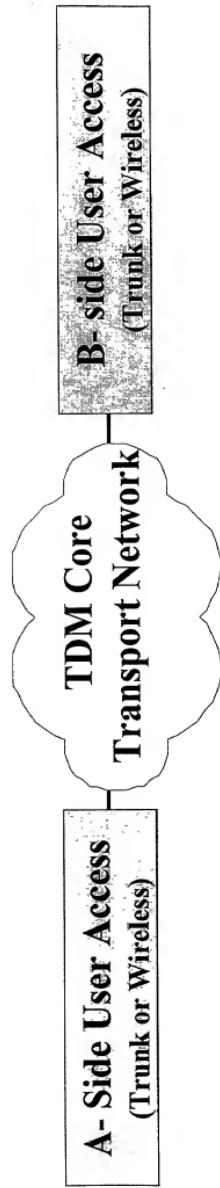
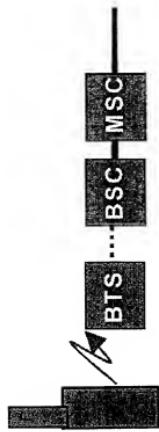


Fig. 33



Term	Abbreviation (Default)	TE Model Input
Electric Circuit Noise (at 0 dB _r)	Nc	(-70 dBm ₀)
Room Noise	P ₀	(35 dB _{RA})
Send Loudness Rating	SLR	(8 dB)
Receive Loudness Rating	RLR	(2 dB)
D-factor	D	(3)
Noise Floor	Nf _{or}	(-64 dBm ₀)
Side-tone Masking Rating	STM R	(1.5)
Equipment Impairment Factor	I _e	(0)
Expectation (Advantage) Factor	A	(0)
Mean Intrinsic One-Way Delay (upper)	T _u	(0 ms)
Mean Intrinsic One-Way Delay (lower)	T _l	(0 ms)
Mean Intrinsic One-Way Delay	T _{ul}	(0 ms)
Electrical Loss (upper)	L _u	(dB)
Electrical Loss (lower)	L _l	(dB)
Electrical Loss (upper = lower)	L _{ul}	(dB)
Quantizing Distortion Units (upper)	qduu	(1) [Note 1]
Quantizing Distortion Units (lower)	qdlu	(1) [Note 1]
Echo Return Loss	ERL	(dB)

Fig. 34



BTS: Base Station
BSC: Base Station Controller
MSC: Mobile Switching Center

PSTN Wireless Access Delay, loss and Impairment Summary		
	Uplink	Downlink
Mobile Switching Center (MSC) (ms)	1	2
Base Station Controller (BSC) (ms)	2.5	40
Base Station (BTS) (ms)	15.8	40.8
Mobile Set (MS) (ms)	72.1	14.3
PSTN Wireless Access Delay (ms)	91.40	97.10
Impairment Factor (le)	5	5

Fig. 35

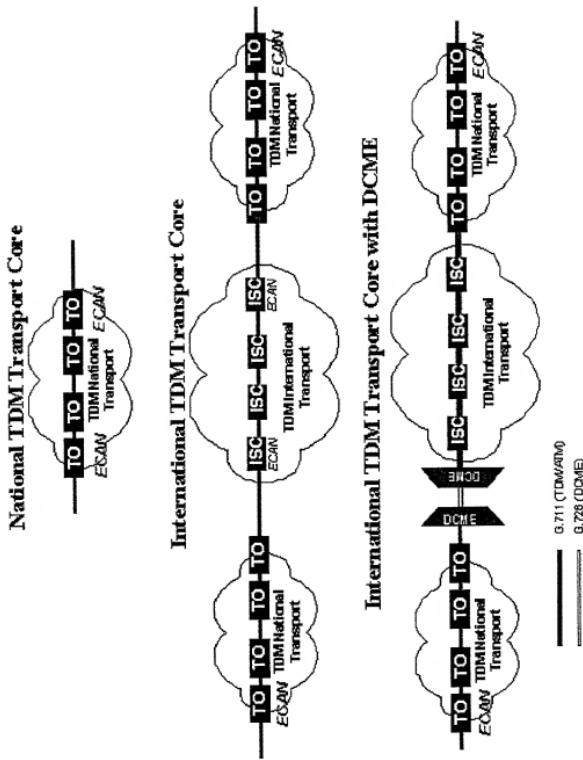


Fig. 36

IDN Core Transport	National (8000km)	International (connection Length 27500 km)			
		0 DCME	1 DCME	2 DCME	3 DCME
National Transmission Time		43	43	43	43
T2DCME (G.711/G.726 Conversion+DS1) (ms)	-	0	26	52	78
DCME2T (G.726/G.711 Conversion) (ms)	-	0	2	4	6
International Transmission Time (ms)	-	72	72	72	72
National Transmission Time		43	43	43	43
Total one-way delay (ms)		43	158	186	214
Impairment Factor (le)		0	0	7	14
					242
					21

Fig. 37

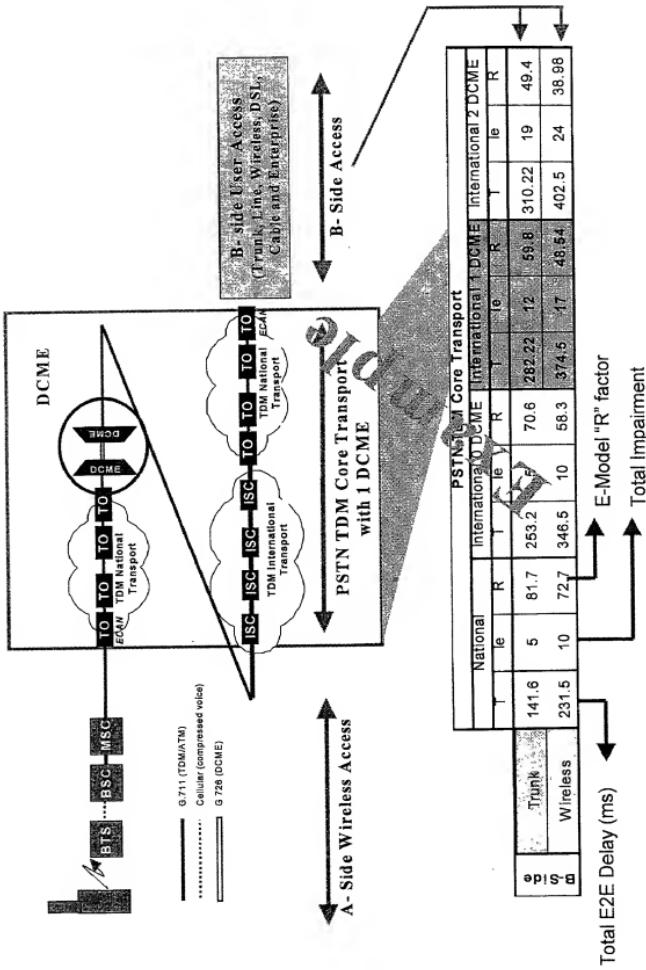
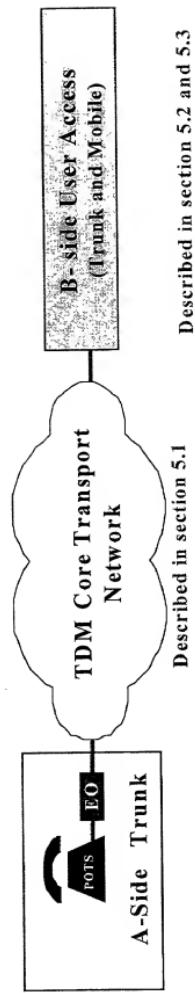
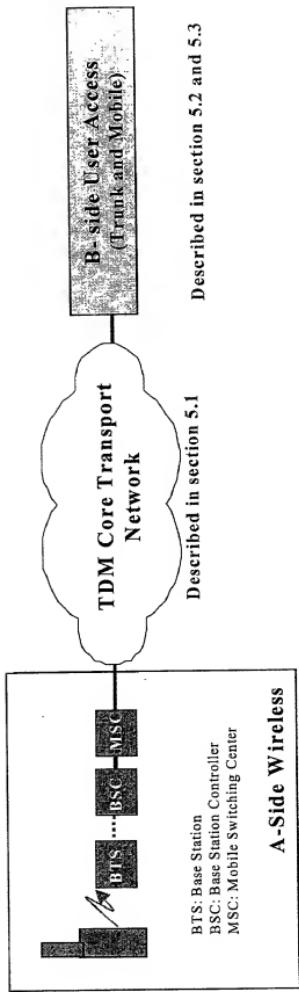


Fig. 38



Trunk Access	National			International 0 DCME			International 1 DCME			International 2 DCME		
	T	Ie	R	T	Ie	R	T	Ie	R	T	Ie	R
to												
Trunk	46	0	87.8	161.22	0	85.8	190.22	7	76.8	218.22	14	66.6
Wireless	139.24	5	81.7	253.22	5	70.6	282.22	12	59.8	310.22	19	49.4

Fig. 39



Described in section 5.2 and 5.3

Wireless Access to	National			International 0 DCME			International 1 DCME			International 2 DCME		
	T	Ie	R	T	Ie	R	T	Ie	R	T	Ie	R
Trunk	141.6	5	81.7	253.2	5	70.6	282.22	12	59.8	310.22	19	49.4
Wireless	231.5	10	72.7	346.5	10	58.3	374.5	17	48.54	402.5	24	38.98

Fig. 40

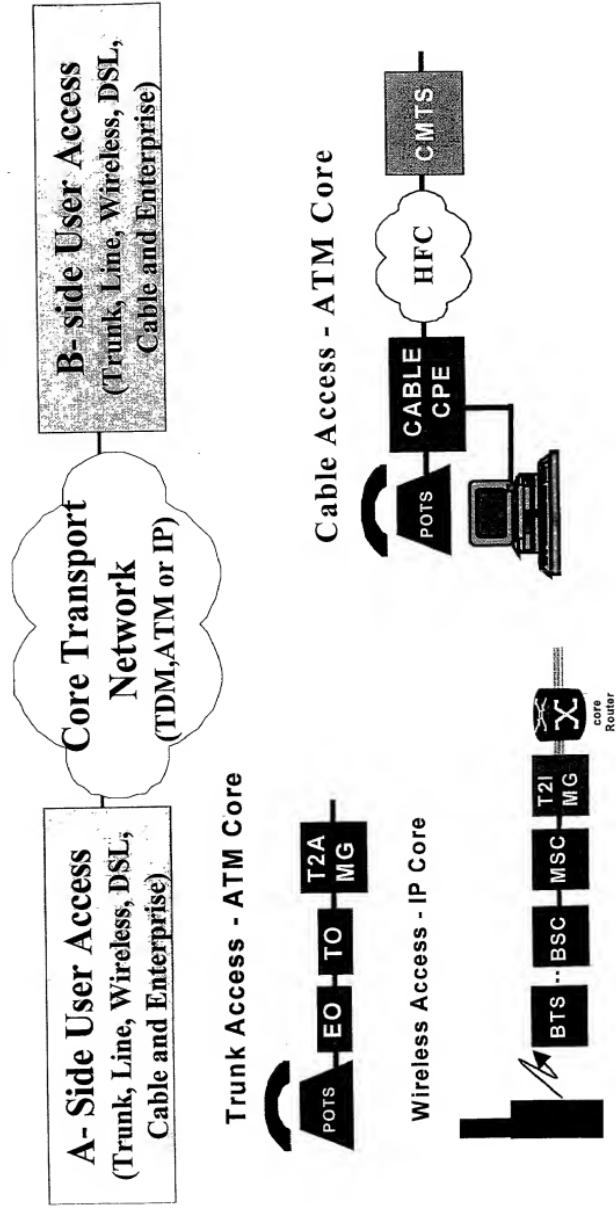


Fig. 41

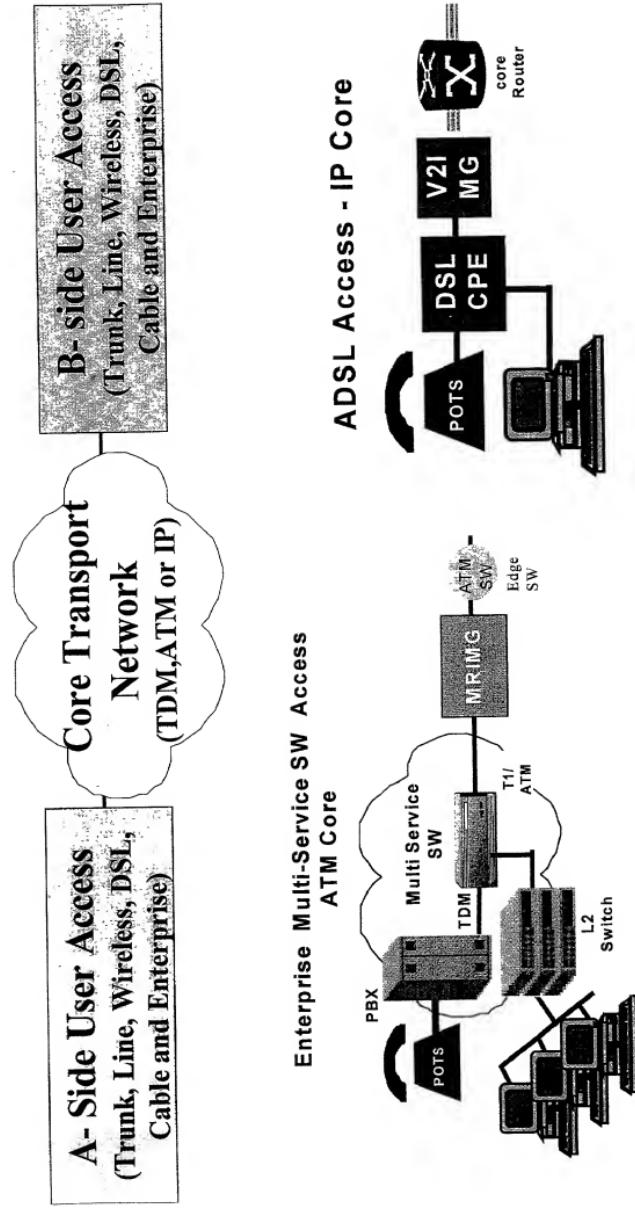


Fig. 42

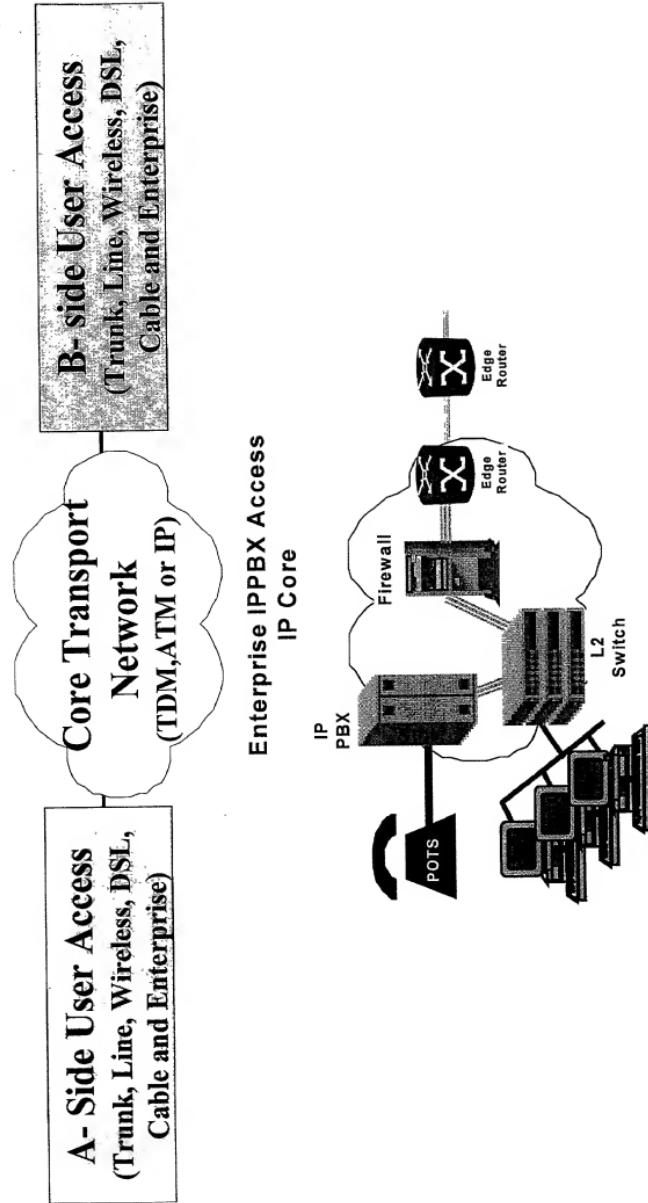


Fig. 43

Which impairments are being considered in the models?

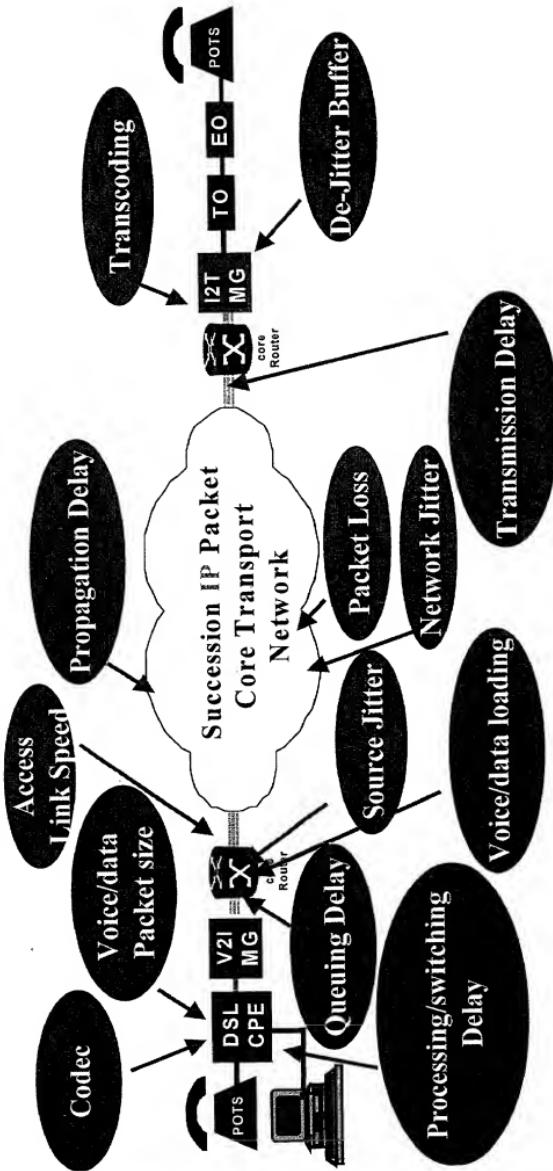


Fig. 44

Trunk Access - ATM Core	
	
Trunk Access to ATM Core (Before 4 parameters budget assignment) Delay, loss and Impairment Summary	
Set delay (Side A) (ms)	0
End Office Delay (Side A) (ms)	1.5
Tandem Office Delay (Side A) (ms)	0.75
T2AMG delay (Side A) (ms)	0.5
Trunk Access delay (ms)	2.75
Impairment Factor (Ie)	0

Fig. 4.5

Wireless Access - IP Core

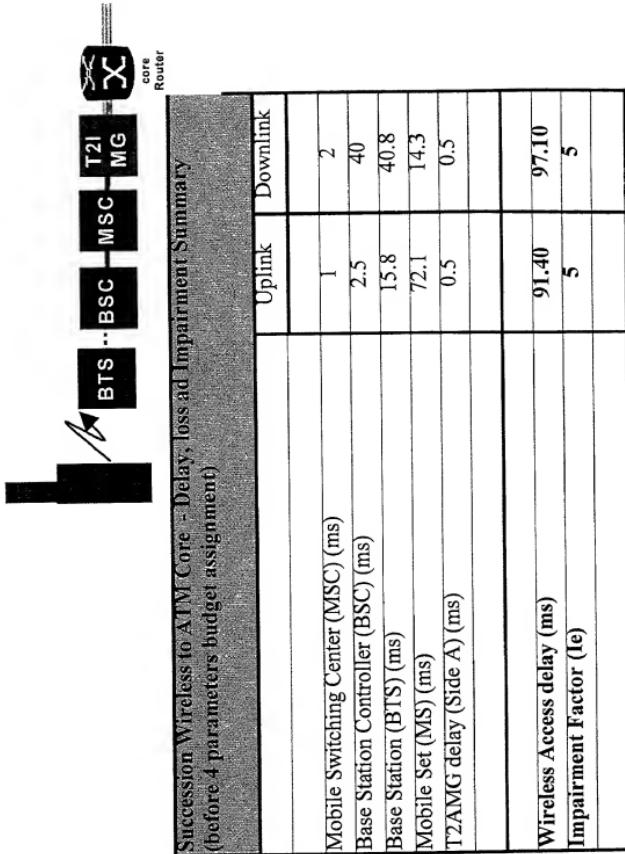
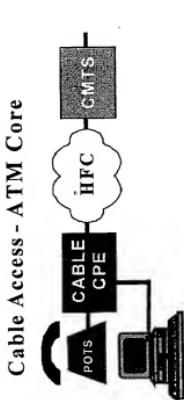


Fig. 46



	Cable CPE	Cable CPE Upstream	Cable CPE Downstream	Note
Link Speed		510 Kbps	3000 Kbps	note [1]
Voice packet size (byte)		160	160	note [2]
Voice packet overhead (RTT/UDP/TCP)		48	48	
Data packet size (byte)		512	512	
Data packet overhead		48	48	
Voice packet link utilization (%)		10.0%	10.0%	
Data packet link utilization (%)		90.0%	90.0%	
Fixed Delay				
- Serialization delay for voice packet (ms)		3.26	0.55	note [3]
- DSP & CPU processing delay (ms)		12.00	14.00	note [4]
- Packetization Delay (ms)		0.00	N/A	note [5]
Variable Delay				
- Average Voice data contention (ms)		4.57	0.78	note [6]
- Maximum Voice data contention (ms)		9.15	1.55	note [6]
- De-Jitter buffer delay (ms)		N/A	0.00	note [5]
Other Impairments				
- Packet Loss (%)		0.00	0.00	note [5]
Minimum Delay (Fixed Delays) (ms)		15.26	14.55	
Average Delay (Fixed+Average Variable Delays) (ms)		19.84	15.33	
Maximum Delay (Fixed+ Max Delays) (ms)		24.41	16.11	

Fig. 47

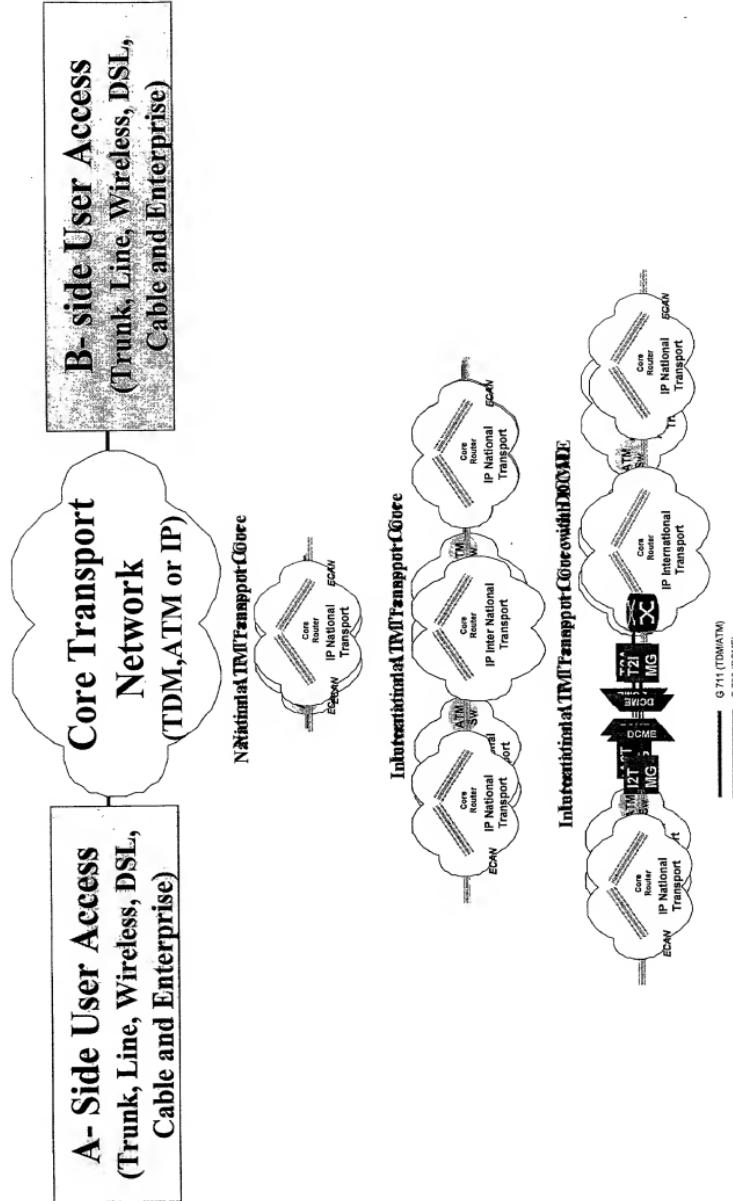


Fig. 48

Total National Transport Distance (km)	8000 km (IP)	8000 km (ATM)	8000 km (TDM)	Note
Terrestrial Distance (km)	8000	8000	8000	
Terrestrial propagation Delay @ 5us / km (ms)	40	40	40	From G.114
Submarine Distance (km)	-	-	-	
Submarine propagation Delay @ 6us / km (ms)	-	-	-	From G.114
Number of hop	5	8	4	From I.356, TIA IS-810
Equipment processing time (ms)	1ms x 5	0.03ms x 8	0.75ms x 4	G.114
Jitter (ms)	note [1]	1.5 note [3]	0	I.356 QoS class 1
Total Delay (ms)	45	41.74	43	Note [2]

International Core Transport Delay	27500 (IP)	27500 (ATM)	27500 (TDM)	Note
Terrestrial Distance (km)	16000	16000	16000	
Terrestrial Delay @ 5us / km (ms)	80	80	80	
Number of hop	15	19	12	From I.356, TIA IS-810
Equipment processing time per hop	1	0.03	0.75	G.114
Equipment processing time (ms)	15	0.57	9	G.115
Submarine Distance (km)	11500	11500	11500	
Submarine Delay @ 6us / km (ms)	69	69	69	
Jitter (ms)	note [1]	3	0	I.356 QoS class 1
Total Delay (ms)	164	149.57	158	Note [2]

Fig. 49

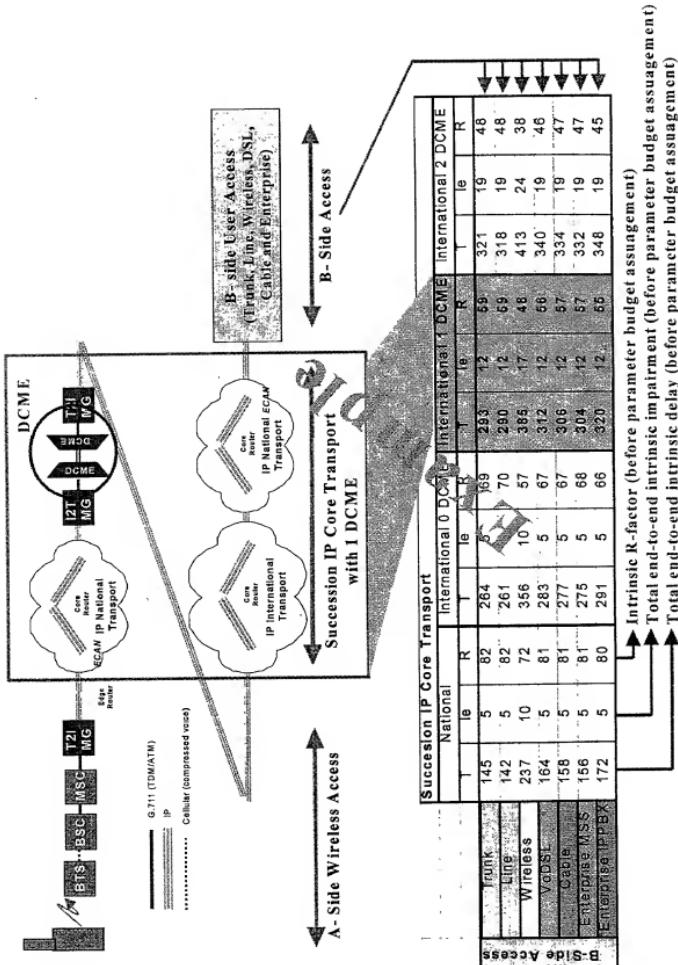
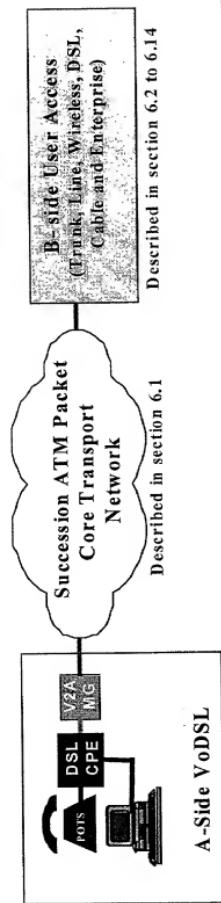


Fig. 50

	ATM Core Transport										
	National			International 0 DCME			International 1 DCME			International 2 DCME	
	Ie	R	Ie	Ie	R	Ie	R	Ie	R	Ie	R
POI-S Trunk	47	0	88	161	0	86	190	7	77	218	14
POI-S Line	45	0	88	159	0	86	188	7	77	216	14
Wireless	139	5	82	253	5	71	282	12	60	310	19
VDSL	66	0	87	180	0	85	209	7	75	237	14
Cable	61	0	88	175	0	85	204	7	75	232	14
Enterprise MSS	48	0	88	162	0	86	191	7	77	219	14
Enterprise IP PBX	64	0	88	178	0	85	207	7	75	235	14

Note: The four parameters: packetization delay, delay jitter, codec and packet loss have been set to zero. Those four parameters will be determined based upon the available margin. The margin is determined based on the benchmark comparison of an end-to-end Succession network with the closest benchmark representation of existing networks (PSTN only, mobile to PSTN, or mobile to mobile).

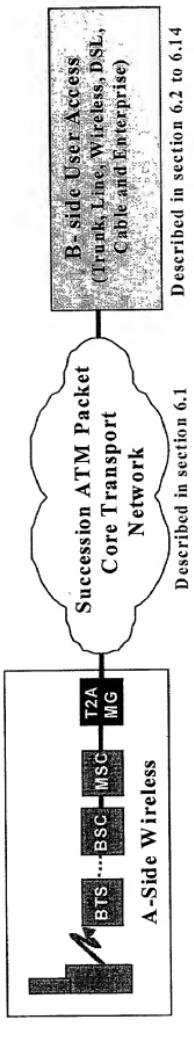
Fig. 51



		ATM Core Transport				International 0 DCME				International 1 DCME				International 2 DCME			
		National		International 0 DCME		International 1 DCME		International 2 DCME		National		International 0 DCME		International 1 DCME		International 2 DCME	
		T	Ie	R	Ie	R	Ie	R	T	Ie	R	Ie	R	Ie	R	Ie	R
POTS Trunk	66	0	87	180	0	85	209	7	75	237	14	64	64	64	64	64	64
POTS Line	64	0	88	178	0	85	207	7	75	235	14	64	64	64	64	64	64
Wireless	158	5	81	272	5	68	301	12	57	329	19	47	47	47	47	47	47
VoDSL	86	0	87	200	0	83	229	7	72	257	14	62	62	62	62	62	62
Cable	80	0	87	194	0	83	223	7	73	251	14	62	62	62	62	62	62
Enterprise MSS	67	0	87	181	0	85	210	7	75	238	14	64	64	64	64	64	64
Enterprise IPPBX	84	0	87	198	0	83	227	7	73	255	14	62	62	62	62	62	62

Note: The four parameters: packetization delay, delay jitter, codec and packet loss have been set to zero. Those four parameters will be determined based upon the available margin. The margin is determined based on the benchmark comparison of an end-to-end Succession network with the closest benchmark representation of existing networks (PSTN only, mobile to PSTN, or mobile to mobile).

Fig. 52



	IP Core Transport								International 2 DCME		
	National		International 0 DCME		International 1 DCME		International 2 DCME		International 2 DCME		
	Ie	R	Ie	R	Ie	R	Ie	R	Ie	R	
POTS Trunk	145	5	86	264	5	74	293	12	63	321	19
POTS Line	142	5	86	261	5	74	290	12	64	318	19
Wireless	237	10	72	356	10	57	385	17	48	413	24
VoDSL	164	5	85	283	5	71	312	12	61	340	19
Enterprise MSS	158	5	85	277	5	72	306	12	62	334	19
Enterprise IPPBX	156	5	85	275	5	72	304	12	62	332	19
	172	5	84	291	5	70	320	12	60	348	19

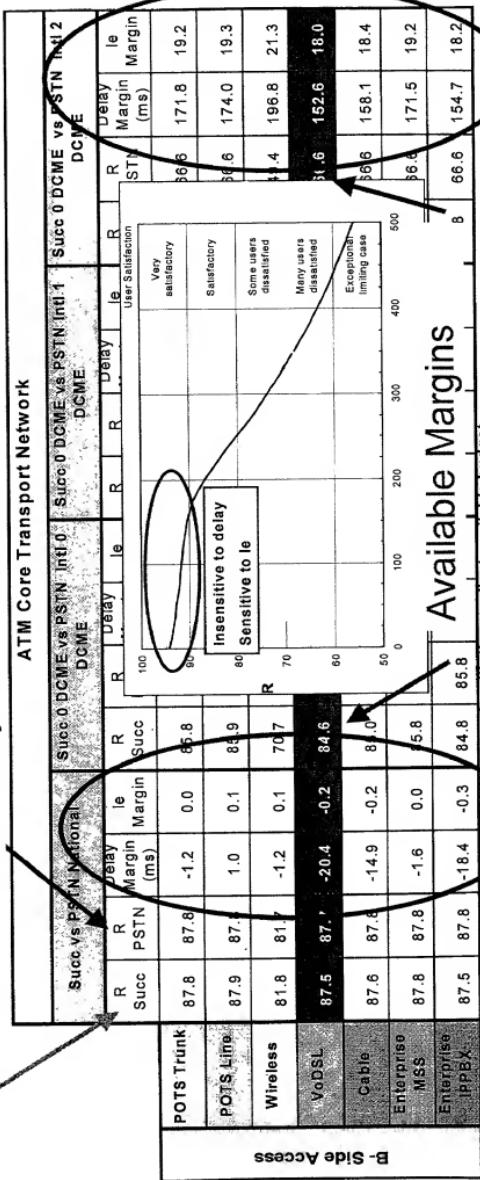
Note: The four parameters: packetization delay, delay jitter, codec and packet loss have been set to zero. Those four parameters will be determined based upon the available margin. The margin is determined based on the benchmark comparison of an end-to-end Succession network with the closest benchmark representation of existing networks (PSTN only, mobile to PSTN, or mobile to mobile).

Fig. 53

R Succession

R "Clarity" Benchmark

ATM Core Transport Network



Note: In red indicates the worst case access scenario with the smallest available budget

Fig. 54

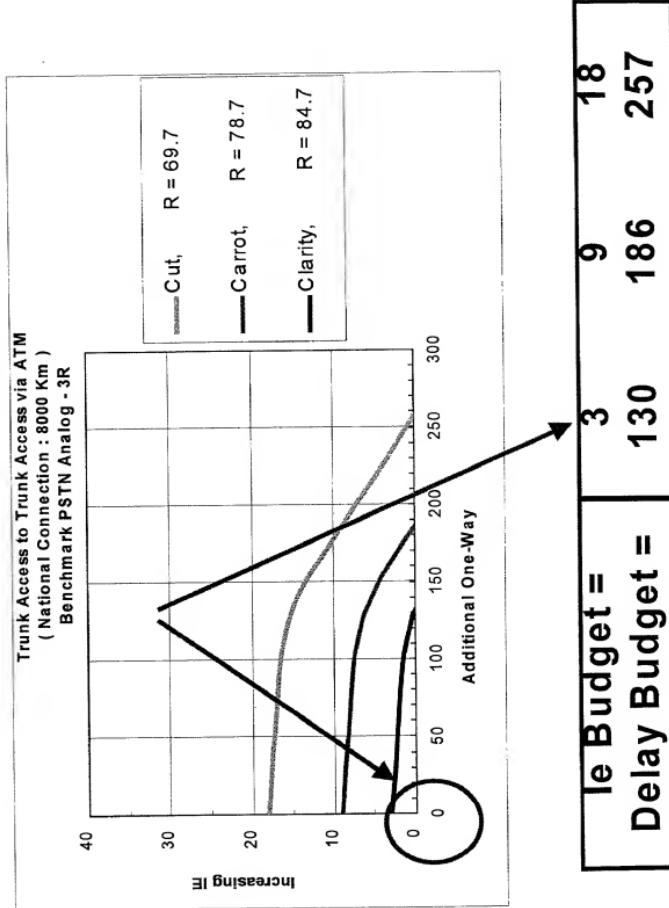
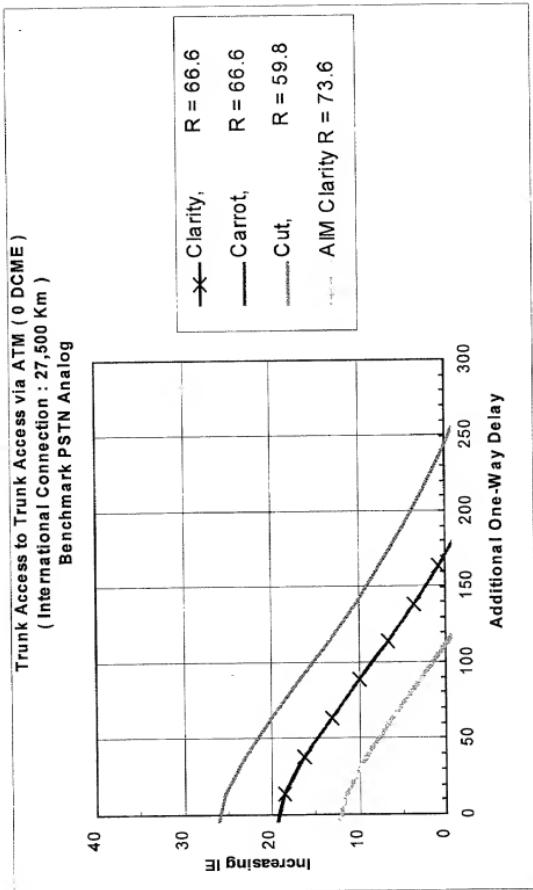


Fig. 55



IE Budget =	12.07	19.07	19.07	25.87
Delay Budget	110.9	171.5	171.5	244.4

Fig. 56

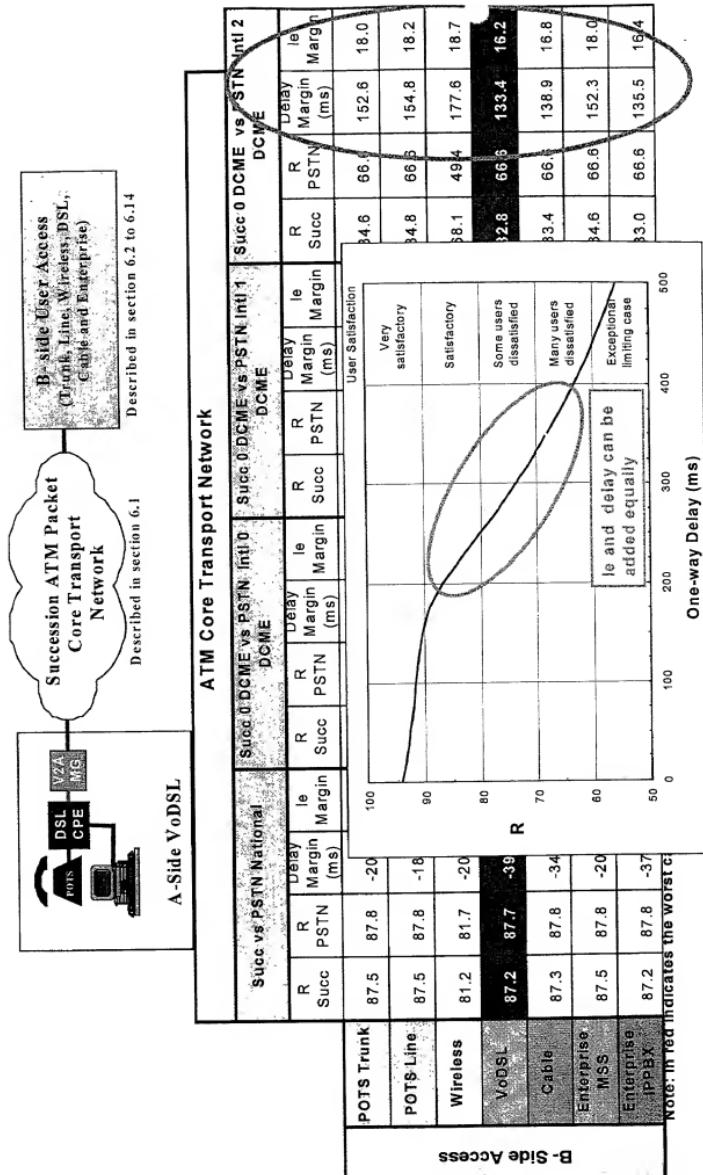


Fig. 57

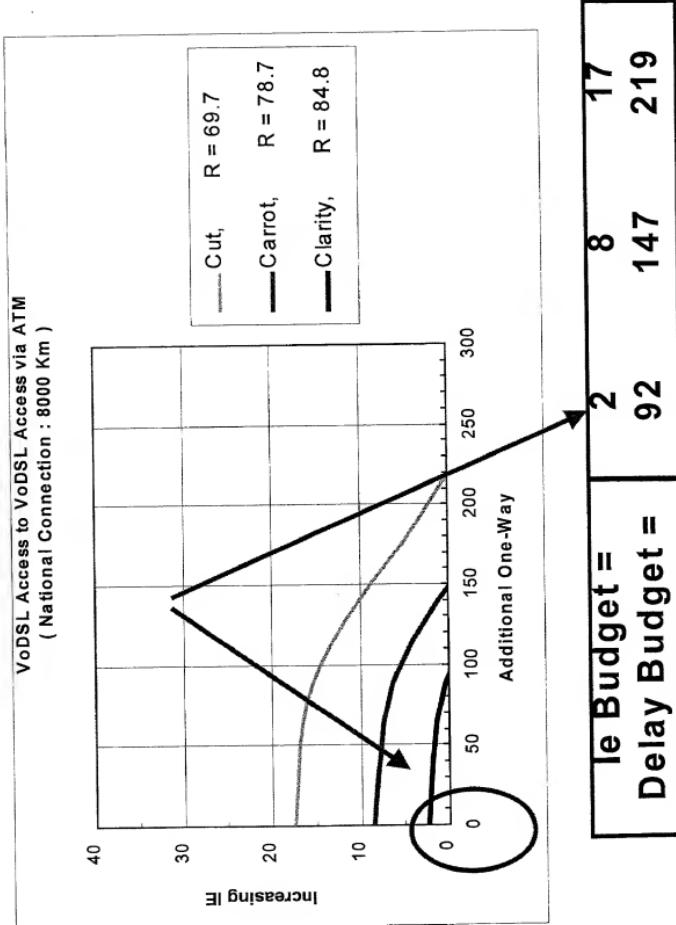


Fig. 58

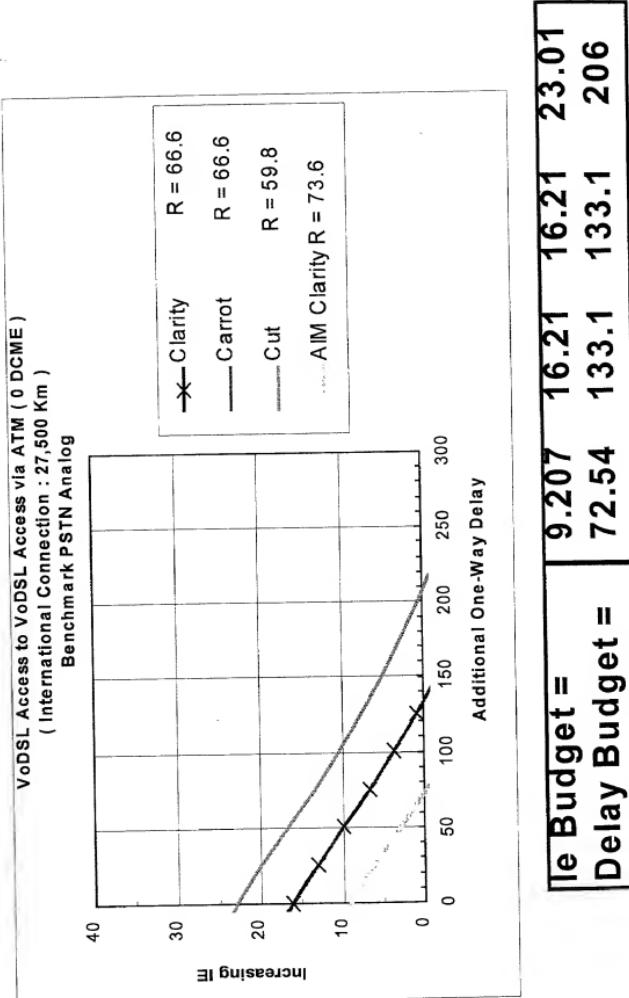


Fig. 59

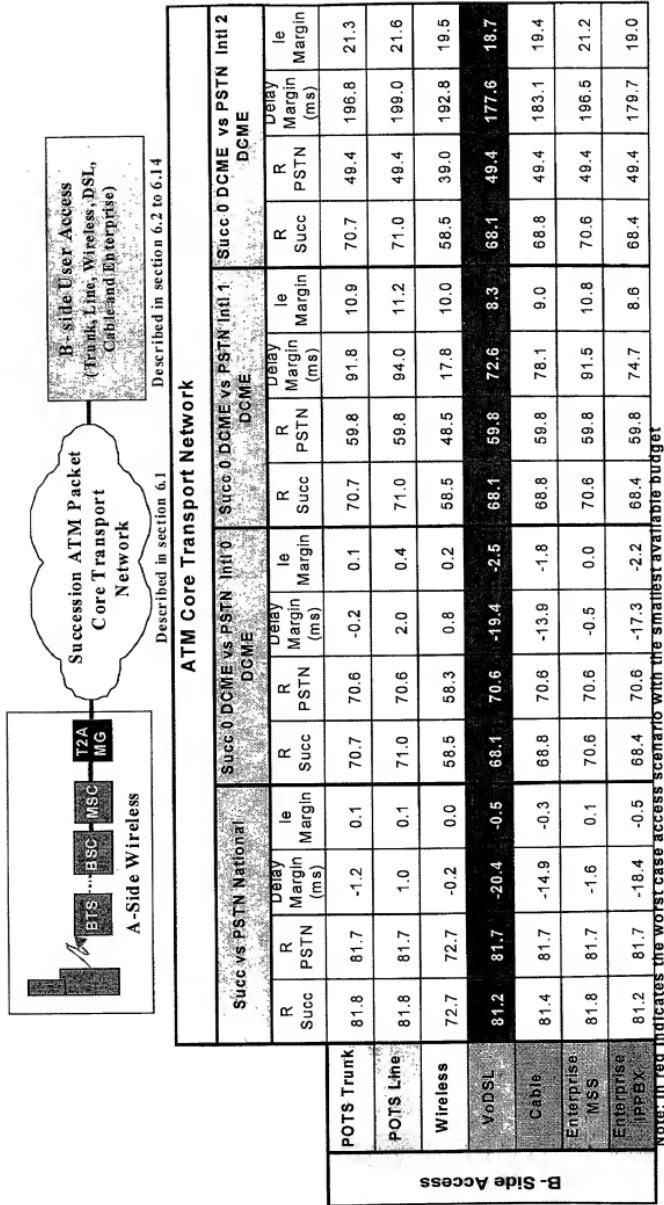
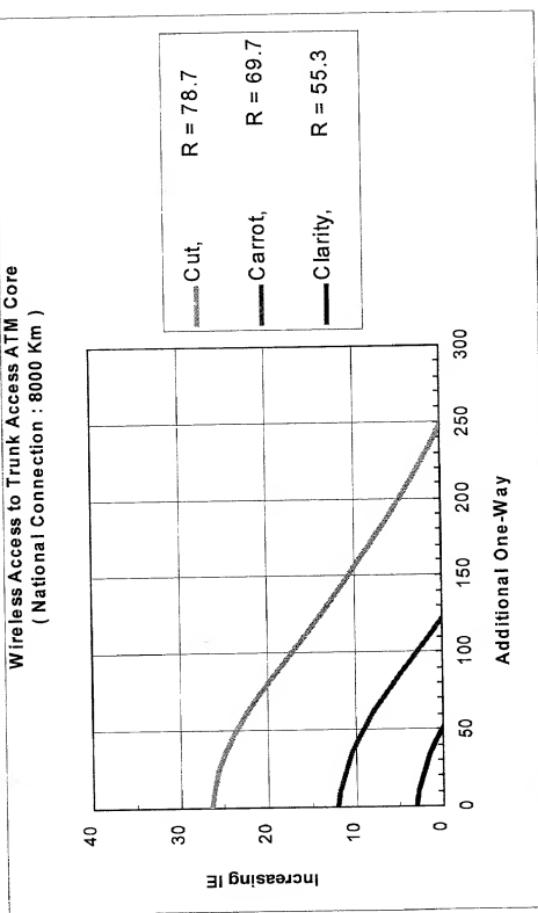


Fig. 60



Le Budget =	3	12	26
Delay Budget =	51	121	249

Fig. 61

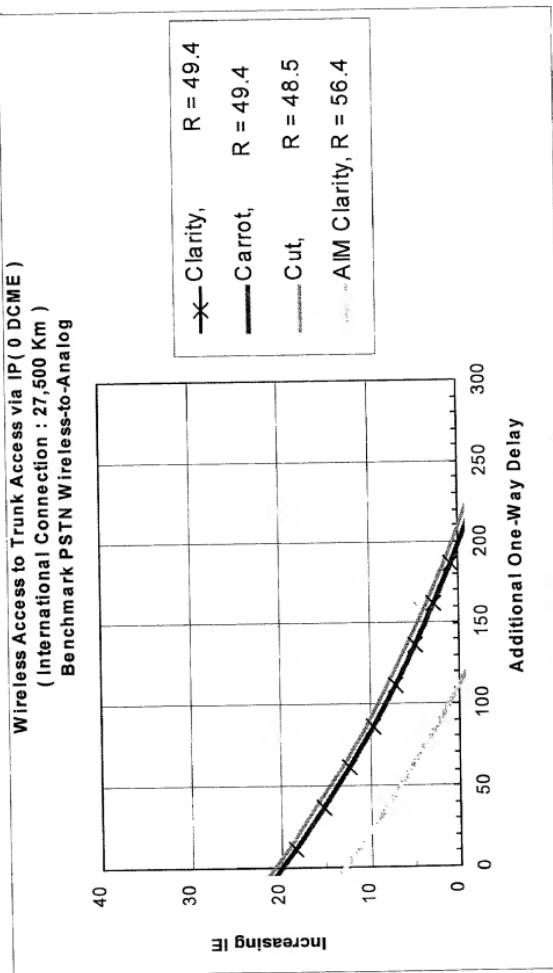


Fig. 62

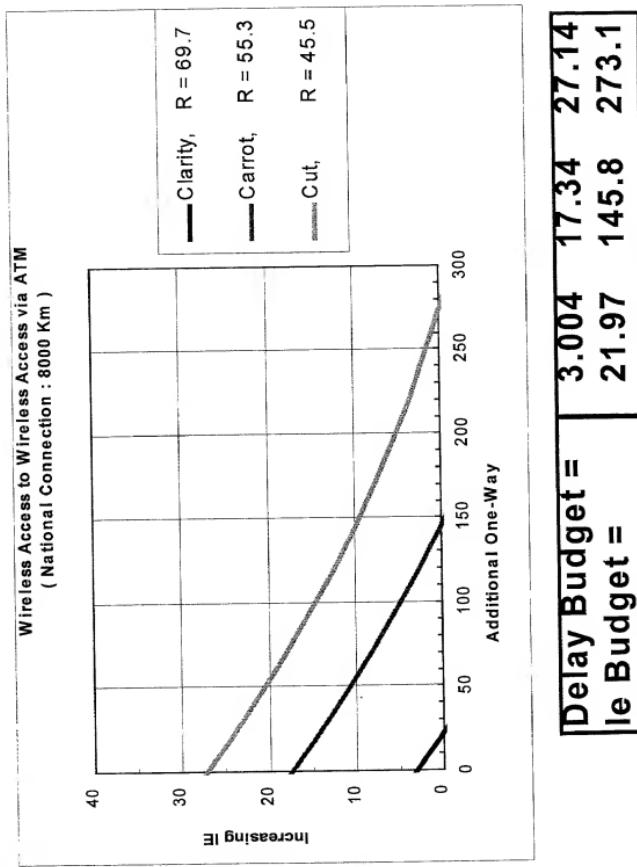
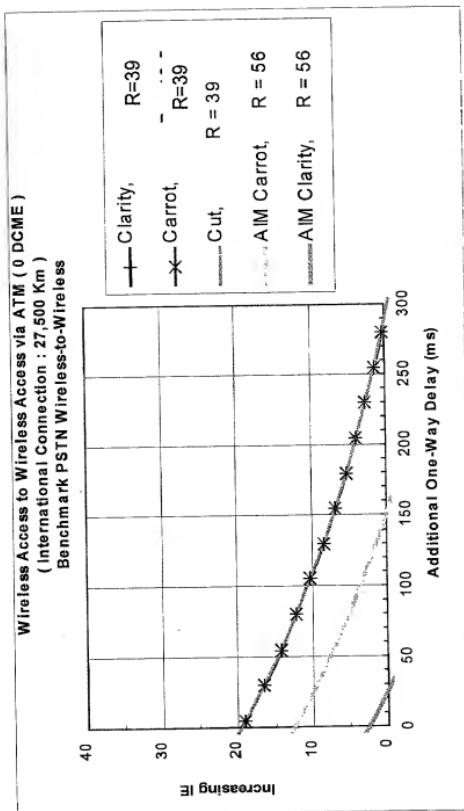


Fig. 63



Bit Budget =	2	12	19	19	19
Delay Budget =	25	151	181	248	289

Fig. 64

Rank	Codec	E-model Impairment Factor (1e)	Estimated implementation delay (m s)	Note
1	G.711 at 64 kb/s	0	0.125	PCM
2	G.726 at 32 kb/s with Sync Coding	7	0.250	ADPCM
3	GSM-EFR	5	40	GSM
4	IS-733	*	40	
5	G.728 at 16 kb/s	7	1.250	
6	G.729/G.729A at 8 kb/s	10/11	25	
7	IS-641	6	40	TDMA
8	G.723.1 at 6.3 kb/s (not recommended)	15	30	Soft Phone

Fig. 65

Codec		packetization delay (ms)	max packet loss (%)	le due to packet loss
type	Codec le			
G.711	0	10	0%	0
G.711	0	20	0%	0
G.726(1)	7	10	0%	0

1. This codec is only really suitable for international

Fig. 66

Codec type	Codec le	packetization delay (ms)	max packet loss (%)	le due to packet loss
G.711	0	10	0%	0
G.711	0	20	0%	0
G.711	0	40	0%	0
G.726	7	10	0%	0
G.726	7	20	0%	0
G.726	7	40	0%	0
G.711	0	10	1%	5
G.711	0	20	1%	5

Fig. 67

Codec		packetization delay (ms)		max packet loss (%)	le due to packet loss
type	Codec le				
G.711	0	10	0%	0	0
G.711	0	20	0%	0	0
G.711	0	40	0%	0	0
G.726	7	10	0%	0	0
G.726	7	20	0%	0	0
G.726	7	40	0%	0	0
G.729	11	10	0%	0	0
G.729	11	20	0%	0	0
G.729	11	40	0%	0	0
G.711	0	10	1%	5	5
G.711	0	20	1%	5	5
G.711	0	40	1%	5	5
G.726	7	10	1%	2	2
G.726	7	20	1%	4	4
G.726	7	40	1%	8	8
G.729	11	10	1%	2	2
G.729	11	20	1%	4	4

Fig. 68

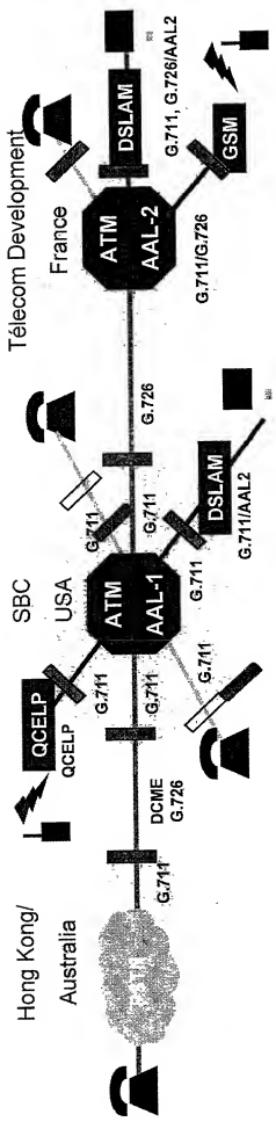


Fig. 69

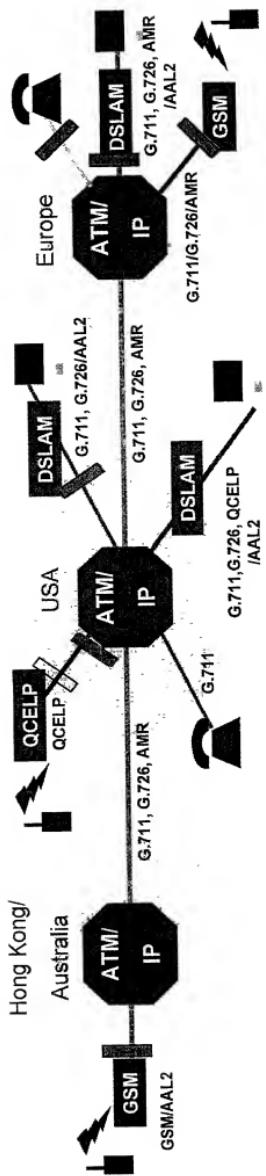
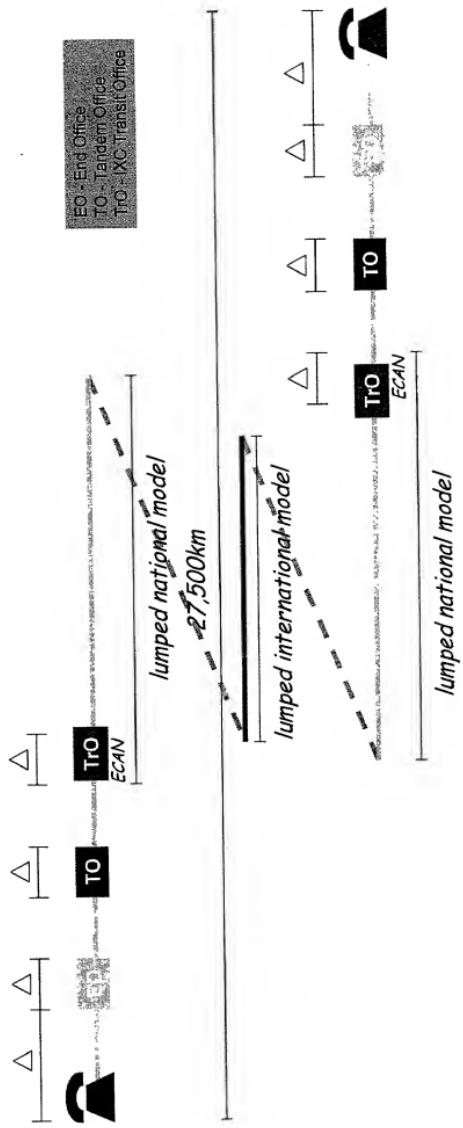


Fig. 70



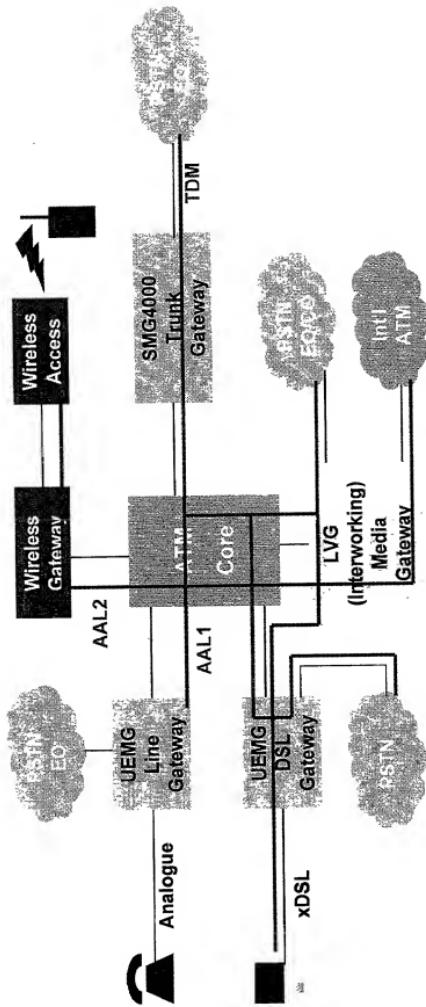
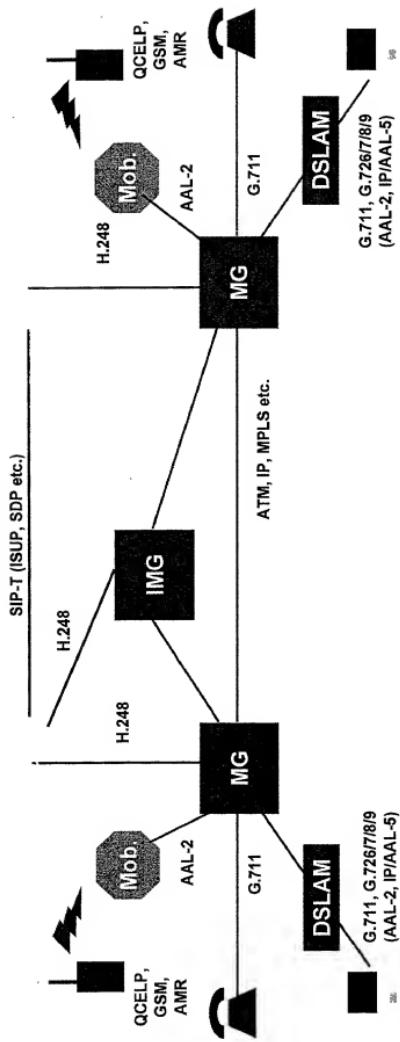
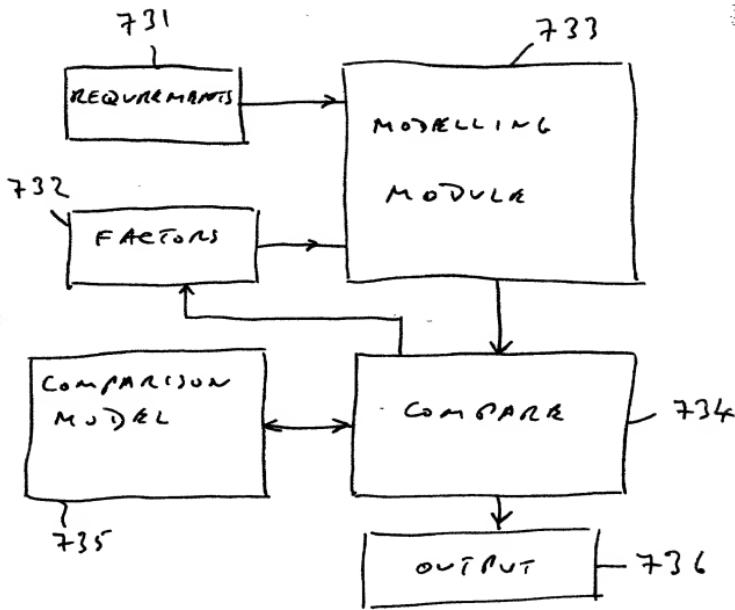


Fig. 71

Fig. 72





73 73